Appendix B

<u>Civil Reports/Studies</u>

Conceptual Drainage Report
Geotechnical Investigation Report

<u>Civil & Landscape Plan Set (full size sheets – 24” x 36”)</u>

C1 Existing Conditions
C2 Rock Removal Grading Plan
C3 Preliminary Grading Plan
C4 Preliminary Cross Sections
C5 Slope Analysis Map
C6 Cut Fill Map
L1 Preliminary Landscape Plan

CONCEPTUAL DRAINAGE REPORT
For
OPHIR HILL SUBDIVISION
SPECIAL USE PERMIT

PROFESSIONAL ENGINEER - STATE OF NEVADA
EDWARD C.
THOMAS
4/28/23
CIVIL
No. 9740
EXP. 6/30/2024

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May, 2023

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1. INTRODUCTION

This document is presented as a Conceptual Drainage Report in support of the proposed 11.35-acre Ophir Hill residential subdivision in Washoe Valley. This report provides support for the Special Use Permit (SUP) for the developed area as required by Washoe County.

The property owner wishes to divide the three existing parcels into four residential parcels. The owner further wishes to apply for a grading permit to grade the site with building pads, driveways, and drainage to prepare for the final development of the residential subdivision. The volume of earthwork that will be required to transform the topography of the site from its current configuration to the final configuration is great enough to trigger the need to apply for a grading SUP as defined by Article 438 of the Washoe County Development Code. To subdivide the land from the three existing parcels to the proposed four residential parcels, the property owner wishes to apply for a Tentative Parcel Map (TPM). The TPM and SUP applications will be applied for and processed simultaneously. This Conceptual Drainage Report supports the SUP application.

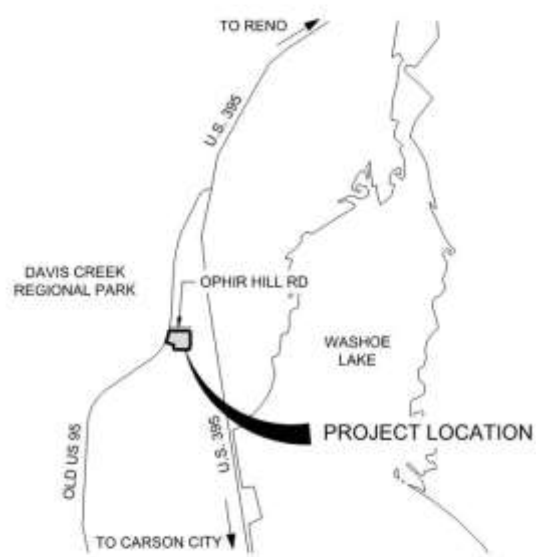

Figure 1: Vicinity Map

1.1. Existing Site Description

The site is located at the base of the Carson Range near the terminus of Ophir Creek in Washoe Valley in unincorporated Washoe County, Nevada (SW ¼, Section 34, Township 17 North, Range 19 E, Mount Diablo Meridian). It is bound on the west by Old US 395, on the north by residentially zoned property, and on the southwest by a residential parcel. The east side and the eastern half of the southern property boundary abuts Bureau of Land Management (BLM) lands. There are two existing structures located on site; one construction shop and one residence. Nearly 100% of the site has been cleared for use as an aggregate processing and stockpiling operation. The site is currently accessed from Old US 395 via Ophir Hill Road. Old US 395 is a Nevada State Maintained Highway (Alt US 395). Ophir Hill road is a dirt driveway that enters at the north boundary of the site. An un-permitted dirt driveway accesses the site directly from Old US 395 along the property's southern border. This driveway has been gated to prevent use by the aggregate operation. There are currently rock and soil stockpiles on the site and some processing equipment remains on the site. The site generally slopes from west to east with an overall grade of approximately 4%.

An existing 36-inch diameter corrugated metal pipe (CMP) culvert conveys runoff from the hills to the west of the project site under Old US 395 and discharges within the Old US 395 near the northwest corner of the site. The flowline of drainage channel downstream of the culvert passes just north of the northwest property corner before continuing in a northeasterly direction across the property to the north of the project site. The southern side slope of the drainage channel extends onto the project site. A small portion of the project site drains to the north and into this existing drainage channel. A small portion of the Old US 395 right-of-way drains directly onto the project site along the southern half of the Old US 395 frontage. Roughly 2/3 of 3280 Old US 395 drains directly onto the project site across the southwestern property line. A small portion of 3210 Ophir Hill Road drains onto the site across the project's northern border. The majority of the project site drains by sheet flow onto the BLM lands to the south and east of the project site. Runoff ultimately flows into Washoe Lake.

There is a 0.82-acre area to the south of the property line for APN 046-032-02 that extends south from the south property line to an existing ranch fence. This area is part of the Bureau of Land Management (BLM) land to the south of the project site and was previously cleared as a part of the aggregate operation. This area will be cleared of processed and palletized aggregates and stockpiled bulk aggregates and will be revegetated with a native seed mixture provided by the BLM. Since this land is offsite, it is not included in the hydrology calculations.

1.2. Proposed Project Description

The proposed 11.35-acre site will be developed into four residential parcels. The parcels will range in size from 2.5 acres to 3.5 acres. The project will be accessed directly from Old US 395 via a proposed shared access driveway. NDOT has been contacted and has given preliminary indication that it will support the formalization of an access point at this location. Two phased preliminary grading plans have been prepared for this project. The first grading phase will show the removal of stockpiled and processed rock. This first grading phase will establish the volume of rock that is to be removed from the site and stored at a location in Lyon County until it can be used or sold by the owner. The second grading phase will show the site in its final configuration of four residential parcels. This report will consider the site after removal of stockpiled and processed rock to represent the site in its existing condition. This is a reasonable hypothesis since the material to be removed is almost entirely composed of stockpiles of large rocks and boulders, which provide only minimal impediment to the transport of runoff from the site. This report will consider the final grading of four residential parcels with associated driveways and drainage improvements to represent the site in its final developed condition

A preliminary grading plan has been prepared which indicates the proposed driveway, parcel access, building pads, drainage swales, drainage culverts, detention pond, and existing and finish contours. The intent of the grading plan is to demonstrate proposed drainage patterns and stormwater detention requirements. A small portion of the project site along its northern border will continue to drain into the existing outfall channel for the Old US 395 culvert, but the amount of runoff reaching this channel will be reduced. The project will continue to receive runoff from a small portion of Old US 395, a small portion of 3210 Ophir Hill Rd., and roughly 2/3 of 3280 Old US 395. Portions of the developed site will be allowed to drain, un-detained, onto the BLM Property. Runoff from paved areas and proposed houses will be collected in drainage swales and culverts and routed to a detention pond. The pond has been designed to reduce the developed peak runoff to existing levels prior to discharge onto the BLM land.

1.3. FEMA FIRM Panels

Based on a review of the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) panel 32031C3350G dated 3/16/2009, part of the southern portion of the site lies within Special Flood Hazard Area A. Zone A is defined as an area subject to inundation by the 1% annual chance flood with no base flood elevations determined. The remainder of the site lies within Zone X (unshaded). Zone X is defined as areas determined to be outside the 0.2% annual chance floodplain. A FIRMette of the project site is included in Appendix A.

2. METHODOLOGY

According to the drainage guidelines for Washoe County Development Code and Truckee Meadows Regional Drainage Manual (TMRDM), the Rational Formula Method was used to generate peak discharges for all drainage hydrologic basins [1]. The peak discharges for the project were calculated using the Rational Method. The Rational Method determines peak runoff by expressing the ground cover, site gradient, and soil type as a ratio relative to an entirely impervious site. Rainfall intensity is derived from the NOAA Atlas 14 for 24-hour duration storms (See Appendix A). The Rational Method uses the following equations to compute peak runoff:

$$Q = CiA$$

Where, Q = Peak Runoff (cfs)
C = Runoff Coefficient (unitless)
i = Rainfall Intensity (in/hr)
A = Area of Drainage Basin (ac)

Runoff coefficients for a variety of surface conditions are defined by the Truckee Meadows Structural Controls Design Manual.

The following runoff coefficients were used for the Ophir Hill Subdivision SUP project:

Table 1: Selected Rational C Values

Landcover Classification	Runoff Coefficient 5-year (C_5)	Runoff Coefficient 100-year (C_{100})
Pavement	0.88	0.93
Roof	0.85	0.87
Gravel Road	0.25	0.50
Lawn/Landscape	0.05	0.30
Desert/Range	0.20	0.50
Cleared Land	0.35	0.45

Rainfall intensity is a function of rainfall duration and is computed using NOAA's Point Precipitation Frequency Estimates function available on the NOAA website. NOAA's system provides pinpoint precipitation estimates by allowing the user to input the exact coordinates of the project site. The highest rainfall intensity occurs when the rainfall duration is equal to the time of concentration for runoff.

In hydrograph theory, time of concentration is defined as the time from the end of excessive rainfall to the end of direct runoff. In practical calculations, time of concentration is the flow time from the most hydraulically remote point in a drainage basin to the point of discharge. Concentration time is therefore a combination of two related factors: initial overland flow time and concentrated flow time. The initial time is based on the distance travelled over the ground surface prior to concentrating into organized channels (sheet flow). The minimum time of concentration is defined by the Truckee Meadows Structural Controls Design Manual for urbanized areas as 5 minutes.

The initial overland flow time is computed using the following equation:

$$t_i = \left[\frac{1.8(1.1 - R)L_0^{\frac{1}{2}}}{S^{\frac{1}{3}}}\right]$$

Where, t_i = Initial overland flow time (min)
R = 5- year Runoff Coefficient (unitless)
L_0 = Length of overland runoff (ft); 500 ft maximum
S = Overland slope (%)

Time of concentrated flow is computed using the following equation:

$$t_n = \frac{L_n}{v_n(60\frac{min}{in})}$$

Where, t_n = Concentrated flow time for segment n (min)
L_n = Length of concentrated flow segment n (unitless)
v_n = Velocity of concentrated flow in segment n (ft)

Time of concentration (t_c) is therefore computed using the following equation:

$$t_c = t_i + \sum_{n=1}^{n} t_n$$

According to TMRDM, in urbanized basins, the time of concentration calculated using the above method shall not exceed the time of concentration computed by the following equation:

$$t_c = L/_{180} + 10$$

Where, L=watershed length (ft)

When in an urbanized area, whichever equation calculates the shorter time of concentration (t_c) value shall be the equation that used. According to TMRDM, the minimum concentration time for urbanized basins is 5 minutes.

According to TMRDM, the peak rate of runoff may not be increased as a result of development. Development of a project site will often result in an increase in impervious surfaces and an increase in the efficiency with which runoff is allowed to travel through the site. These increases combine to cause an increase in peak runoff from an equivalent rainfall volume. In this project, a detention basin is proposed to be used to control the rate of runoff leaving the project site.

The Modified Rational Method was used to estimate the detention volume that would be required to reduce the peak rate of runoff from the developed site to the pre-development rate of runoff. The Modified Rational Method plots the proposed pond inflow runoff hydrograph over a hydrograph, which represents the desired peak rate of discharge. The difference between the areas of under the two hydrographs represents the required storage volume. A sequence of proposed inflow hydrographs is plotted and computed against the desired outflow hydrograph. The first comparison assumes that the rainfall duration is equal to the time of concentration. In subsequent comparisons, the rainfall duration is increased, which causes peak runoff to decrease as the length of the hydrograph increases. Rainfall durations are increased until the resultant peak storage volume stops increasing and begins to decrease. The duration that results in the greatest peak storage is used to determine the storage volume of the detention pond.

3. HISTORIC DRAINAGE SYSTEM

A large area to the west of Old US 395 contributes runoff to the existing 36-inch CMP culvert, which conveys runoff under Old US 395 toward the northwest corner of the project site. This runoff does not actually reach the project site, but it is significant, so it has been calculated for this study. Table 2 describes the runoff reaching the existing NDOT culvert

Table 2: Old US 395 Culvert (Pre-development)

Sub-basin ID	Description	Area [ac]	Tc [min]	C_5	C_{100}	I_5 [in/hr]	I_{100} [in/hr]	Q_5 [cfs]	Q_{100} [cfs]
NDOT Culvert	Offsite	48.60	30.11	0.20	0.50	0.94	2.31	9.18	56.19

Several offsite areas contribute runoff, which enter the Ophir Hill Subdivision site. Table 3 describes the runoff that enters the site from the offsite areas. Please refer to Appendix C for existing sub-basin area descriptions.

Table 3: Offsite Areas Draining onto Project Site (Pre-development)

Sub-basin ID	Description	Area [ac]	Tc [min]	C_5	C_{100}	I_5 [in/hr]	I_{100} [in/hr]	Q_5 [cfs]	Q_{100} [cfs]
A1	From 046-032-01	3.13	21.06	0.13	0.37	1.17	2.81	0.48	3.25
A2	From NDOT	0.23	10.00	0.44	0.65	1.66	3.97	0.17	0.59
A3	From 046-032-08	0.05	10.00	0.20	0.50	1.66	3.97	0.02	0.10

A portion of the existing project site drains onto the private property to the north of the project site and into the outfall swale from the NDOT culvert. Table 4 represents the portion of the project site draining to the north. Please refer to Appendix C for existing sub-basin area descriptions.

Table 4: On-site Area Draining to North (Pre-development)

Sub-basin ID	Description	Area [ac]	Tc [min]	C_5	C_{100}	I_5 [in/hr]	I_{100} [in/hr]	Q_5 [cfs]	Q_{100} [cfs]
B2	To 046-032-06	0.53	10.00	0.35	0.45	1.66	3.97	0.31	0.95

The majority of the Ophir Hill Subdivision site drains onto BLM lands to the east and to the south of the project site. Table 5 represents the portion of the project site which drains directly to BLM lands. Please refer to Appendix C for existing sub-basin area descriptions.

Table 5: Onsite Areas Draining onto BLM Lands (Pre-development)

Sub-basin ID	Description	Area [ac]	Tc [min]	C_5	C_{100}	I_5 [in/hr]	I_{100} [in/hr]	Q_5 [cfs]	Q_{100} [cfs]
B1	Onsite to BLM	10.76	20.26	0.35	0.45	1.19	2.87	4.53	13.98

Table 6 represents the combined runoff entering the project site from offsite sources, the total onsite runoff discharged onto neighboring private property, and the total runoff being discharged onto BLM lands from the project site only and from the offsite areas and onsite areas combined.

Table 6: Drainage Summary (Pre-development)

Basin Description	Area [ac]	Tc [min]	C_5	C_{100}	I_5 [in/hr]	I_{100} [in/hr]	Q_5 [cfs]	Q_{100} [cfs]
Offsite Areas Draining onto Project Site	3.41	21.06	0.35	0.45	1.17	2.81	0.61	3.74
Onsite Areas Draining onto Private Lands	0.53	10.00	0.35	0.45	1.66	3.97	0.31	0.95
Onsite Areas Only Draining onto BLM Lands	10.76	18.60	0.35	0.45	1.24	3.00	4.73	14.59
Onsite and Offsite Areas Combined Draining onto BLM Lands	14.17	19.05	0.31	0.44	1.17	2.81	5.32	18.37

All calculations can be found in Appendix B.

4. PROPOSED DRAINAGE SYSTEM

Development of the Ophir Hill Subdivision will consist of four residential parcels that will be accessed from Old US 395 by a shared private driveway. The lots will be graded in a manner that will ensure that runoff from impervious surfaces will be carried in drainage swales and culverts to detention pond located on the southeast parcel. Portions of the project site will be allowed to drain directly onto BLM property without passing through the detention pond. The detention pond will be sized so that the total peak runoff reaching the BLM land from the developed site is no greater than the total peak runoff reaching the BLM land from the pre-development site.

The existing project site has been completely cleared for the aggregate processing and stockpiling operations that previously occurred on the site. Portions of the developed site that will not be developed with houses, driveways, or landscaping will be revegetated with native seed mixtures.

Table 7 represents the offsite basins that drain onto the project site. Please refer to Appendix C for proposed sub-basin area descriptions.

Table 7: Offsite Areas Draining onto Project Site (Proposed)

Sub-basin ID	Description	Area [ac]	Tc [min]	C_5	C_{100}	I_5 [in/hr]	I_{100} [in/hr]	Q_5 [cfs]	Q_{100} [cfs]
C1	From 046-032-01	3.14	16.94	0.16	0.39	1.30	3.13	0.67	3.97
C2	From NDOT	0.23	10.00	0.50	0.69	1.66	3.97	0.19	0.63
C3	From 046-032-08	0.04	10.00	0.20	0.50	1.66	3.97	0.01	0.08

As in the pre-development condition, a small portion of the developed Ophir Hill Subdivision site will drain into the Old US 395 culvert outflow swale on the property to the north of the site. Table 8 represents the portion of the developed project site that drains onto the private property to the north. Please refer to Appendix C for proposed sub-basin area descriptions.

Table 8: On-site Area Draining to North (Proposed)

Sub-basin ID	Description	Area [ac]	Tc [min]	C_5	C_{100}	I_5 [in/hr]	I_{100} [in/hr]	Q_5 [cfs]	Q_{100} [cfs]
D9	To 046-032-06	0.03	10.00	0.20	0.50	1.66	3.97	0.01	0.06

By studying Table 8, it can be seen that the overall area of the developed Ophir Hill Subdivision site that drains onto the private land to the north is reduced below pre-development levels. Additionally, by revegetating the site, the runoff coefficients can be reduced. The result is that the peak runoff being discharged onto the private property to the north of the Ophir Hill Subdivision site is reduced.

Table 9 represents the onsite areas draining directly onto BLM lands without passing through the detention pond. Please refer to Appendix C for proposed sub-basin area descriptions.

Table 9: Un-detained Onsite Areas Draining onto BLM Lands (Proposed)

Sub-basin ID	Description	Area [ac]	Tc [min]	C_5	C_{100}	I_5 [in/hr]	I_{100} [in/hr]	Q_5 [cfs]	Q_{100} [cfs]
D1	Onsite to BLM	2.14	17.18	0.20	0.50	1.29	3.11	0.55	3.32

By comparing Table 9 to Table 5, it can be seen that the rate of runoff from onsite sources reaching the BLM property directly has been reduced. This is due to a reduction of area draining directly to BLM lands.

Table 10 represents the combined runoff entering the project site from offsite sources, the total onsite runoff discharged onto neighboring private property, and the total runoff being discharged onto BLM lands from the project site only and from the offsite areas and onsite areas combined.

Table 10: Drainage Summary (Proposed)

Basin Description	Area [ac]	Tc [min]	C_5	C_{100}	I_5 [in/hr]	I_{100} [in/hr]	Q_5 [cfs]	Q_{100} [cfs]
Offsite Areas Draining onto Project Site	3.41	16.40	0.19	0.41	1.32	3.17	0.84	4.47
Onsite Areas Draining onto Private Lands	0.03	10.00	0.20	0.50	1.66	3.97	0.01	0.06
Un-detained Onsite Areas Only Draining onto BLM Lands	2.14	17.18	0.20	0.50	1.29	3.11	0.55	3.32
Un-detained Onsite and Offsite Areas Combined Draining onto BLM Lands	5.32	17.57	0.18	0.44	1.28	3.08	1.21	7.13
Onsite and Offsite Areas Draining to Detention Pond	9.44	11.70	0.29	0.55	1.54	3.67	4.23	19.19

The runoff draining from the Ophir Hill Subdivision site onto the private property to the north of the project site has been decreased, but the overall runoff reaching the BLM lands has been increased as a result of the proposed development. The increase in runoff reaching the BLM land is due to an increase in the efficiency of the pathways for runoff to reach the discharge points. Washoe County requires that the peak runoff leaving a developed site may not exceed the pre-development rate of runoff. In order to reduce peak runoff, a detention pond is utilized to allow runoff to be temporarily stored while being released at a prescribed rate.

To determine the required volume of runoff, one must first establish the required discharge rate. In the case of the Ophir Hill Subdivision, a portion of the developed project site will be allowed to flow onto BML land as un-detained sheet flow or moderately confined shallow overland flow. The remainder of the site will pass through the detention pond. These two general areas have different times of concentration, so the peak flows are not directly additive. In order to determine a peak rate of runoff, the hydrographs of the two areas must be added.

The rates of onsite runoff discharging onto BLM lands in the pre-development condition are:

Q_5=4.73 cfs
Q_{100}=14.59 cfs.

By combining hydrographs, the proposed pre-detention rates of runoff discharging to BLM lands are:

Q_5=5.56 cfs
Q_{100}=22.17 cfs.

As can be seen, both the 5-year rate of runoff and the 100-year rate of runoff have been increased due to development of the Ophir Hill Subdivision project. It is therefore necessary to detain runoff from both the 5-year storm and the 100-year storm. The detention pond will be sized to ensure that the proposed peak 100-year runoff does not exceed pre-development levels. If the volume of the pond is great enough to control the peak runoff from the 100-year storm, it can be assumed that the volume of the pond is also great enough to control the runoff from the 5-year storm, and the outlet can be staged to also control the peak runoff from the 5-year storm. A portion of the proposed Ophir Hill Subdivision site is allowed to drain directly onto BLM lands, which means that the runoff routed to the detention pond must be detained to an outlet rate that does not cause an overall increase in runoff when combined with the peak un-detained runoff.

The total runoff leaving the project site in the 5-year storm must be reduced by 0.83 cfs, and the 100-year storm must be reduced by 7.58 cfs. In order to accommodate the portion of the site that drains directly to BLM lands without detention, the discharge from the detention pond must be reduced to 3.40 cfs in the 5-year storm and to 12.32 cfs in the 100-year storm to ensure that the proposed rate of runoff reaching BLM lands does not exceed pre-development levels.

By using the Modified Rational Method, it was determined that a detention pond with a volume of at least 6,602 cubic feet is required to reduce the peak 100-year runoff to the pre-development rate. As currently shown, the volume of the detention pond has as volume of approximately 14,800 cubic feet.

5. WATER QUALITY

As required by the TMRDM, Low Impact Development (LID) methods of treating runoff will be required to address water quality. Flow-based controls will be designed to treat runoff from the 2-year storm event (WQ_F). All areas that are not either paved, covered with a structure, or landscaped will be revegetated using a native seed mixture. Hardscape improvements will drain to proposed vegetated swales which will convey runoff to the detention pond. The swales will remove collected sediments and will be supplemented by the stilling effect of the detention pond to meet the Truckee Meadows Structural Controls Design and Low Impact Development Manual [4]. Swale and riprap calculations will be included in the final design.

6. CONCLUSIONS

The Ophir Hill Subdivision project will be constructed on a previously disturbed site. Improvements to the site will include private driveways, four single-family residences, drainage swales, culverts, a detention pond and revegetation of exposed earth. Development of the project will result in an increase in peak runoff over pre-development conditions in both the 5-year storm and the 100-year storm. The increase in runoff in can be easily mitigated by the use of a small detention pond. Runoff from the project site to neighboring private property will be reduced with development, and runoff reaching public lands will be reduced to pre-development levels or less. No adverse effects are expected to downstream lands.

References

[1] Washoe County, "Truckee Meadows Regional Drainage Manual," Reno, 2009.

[2] National Oceanic and Atmospheric Administration (NOAA), "Atlas 14 Precipitation-Frequency Atlas," 2018. [Online]. Available: https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk.

[3] United States Department of Agriculture (USDA), "Web Soil Survey," 2020. [Online]. Available: https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx

[4] NCE, "Truckee Meadows Structural Controls Design and Low Impact Development Manual," Reno, NV, April 2015.

APPENDIX A

- FEMA FIRM PANEL
- NOAA RAINFALL INTENSITY

APPENDIX A.1 FEMA FIRMETTE

National Flood Hazard Layer FIRMette

FEMA

119°49'57"W 39°17'51"N

119°49'20"W 39°17'23"N

0 250 500 1,000 1,500 2,000 Feet

1:6,000

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
- 8 Coastal Transect
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 6/21/2022 at 4:35 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

APPENDIX A.2 - RAINFALL INTENSITY - OFFSITE AREA

NOAA Atlas 14, Volume 1, Version 5
Location name: Washoe Valley, Nevada, USA*
Latitude: 39.2977°, Longitude: -119.8413°
Elevation: 5621.51 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**1.40** (1.21-1.66)	**1.75** (1.52-2.06)	**2.32** (1.98-2.74)	**2.84** (2.41-3.36)	**3.72** (3.07-4.42)	**4.52** (3.62-5.42)	**5.47** (4.21-6.67)	**6.62** (4.88-8.26)	**8.46** (5.84-10.8)	**10.2** (6.65-13.3)
10-min	**1.07** (0.924-1.26)	**1.33** (1.16-1.57)	**1.76** (1.51-2.08)	**2.17** (1.84-2.56)	**2.83** (2.34-3.36)	**3.44** (2.76-4.13)	**4.16** (3.21-5.08)	**5.04** (3.71-6.29)	**6.44** (4.45-8.26)	**7.74** (5.06-10.2)
15-min	**0.884** (0.764-1.04)	**1.10** (0.956-1.30)	**1.46** (1.24-1.72)	**1.79** (1.52-2.12)	**2.34** (1.94-2.78)	**2.85** (2.28-3.42)	**3.44** (2.65-4.20)	**4.16** (3.07-5.20)	**5.32** (3.68-6.82)	**6.40** (4.18-8.39)
30-min	**0.596** (0.514-0.702)	**0.740** (0.644-0.876)	**0.980** (0.838-1.16)	**1.21** (1.02-1.42)	**1.58** (1.30-1.87)	**1.92** (1.53-2.30)	**2.32** (1.78-2.82)	**2.80** (2.07-3.50)	**3.59** (2.48-4.60)	**4.31** (2.82-5.65)
60-min	**0.368** (0.319-0.434)	**0.458** (0.398-0.542)	**0.607** (0.519-0.718)	**0.746** (0.634-0.882)	**0.976** (0.806-1.16)	**1.19** (0.950-1.42)	**1.43** (1.11-1.75)	**1.74** (1.28-2.17)	**2.22** (1.53-2.84)	**2.66** (1.74-3.50)
2-hr	**0.246** (0.218-0.278)	**0.304** (0.270-0.346)	**0.384** (0.339-0.436)	**0.454** (0.396-0.515)	**0.558** (0.474-0.634)	**0.650** (0.538-0.750)	**0.757** (0.610-0.888)	**0.898** (0.698-1.09)	**1.14** (0.844-1.44)	**1.36** (0.970-1.77)
3-hr	**0.200** (0.179-0.224)	**0.248** (0.225-0.279)	**0.307** (0.274-0.343)	**0.354** (0.315-0.396)	**0.419** (0.367-0.473)	**0.475** (0.409-0.540)	**0.536** (0.453-0.617)	**0.628** (0.519-0.735)	**0.780** (0.627-0.966)	**0.922** (0.722-1.19)
6-hr	**0.145** (0.129-0.162)	**0.180** (0.161-0.202)	**0.221** (0.196-0.248)	**0.252** (0.223-0.283)	**0.292** (0.255-0.331)	**0.323** (0.278-0.368)	**0.352** (0.298-0.406)	**0.387** (0.322-0.453)	**0.440** (0.357-0.522)	**0.487** (0.388-0.602)
12-hr	**0.097** (0.087-0.109)	**0.122** (0.109-0.137)	**0.152** (0.135-0.171)	**0.175** (0.154-0.198)	**0.206** (0.179-0.234)	**0.230** (0.197-0.263)	**0.254** (0.214-0.293)	**0.277** (0.230-0.325)	**0.309** (0.249-0.370)	**0.333** (0.263-0.406)
24-hr	**0.069** (0.061-0.079)	**0.086** (0.077-0.099)	**0.109** (0.097-0.125)	**0.128** (0.113-0.147)	**0.154** (0.134-0.177)	**0.175** (0.151-0.202)	**0.197** (0.169-0.229)	**0.221** (0.186-0.258)	**0.253** (0.209-0.298)	**0.278** (0.226-0.332)
2-day	**0.042** (0.036-0.049)	**0.053** (0.046-0.062)	**0.068** (0.059-0.079)	**0.080** (0.069-0.094)	**0.098** (0.083-0.115)	**0.112** (0.095-0.132)	**0.127** (0.106-0.152)	**0.143** (0.118-0.172)	**0.166** (0.134-0.202)	**0.185** (0.145-0.228)
3-day	**0.033** (0.029-0.038)	**0.042** (0.037-0.049)	**0.055** (0.048-0.064)	**0.066** (0.057-0.076)	**0.081** (0.069-0.094)	**0.093** (0.080-0.109)	**0.107** (0.090-0.126)	**0.122** (0.101-0.144)	**0.143** (0.116-0.171)	**0.160** (0.127-0.194)
4-day	**0.029** (0.025-0.033)	**0.037** (0.032-0.042)	**0.048** (0.042-0.056)	**0.058** (0.051-0.067)	**0.072** (0.062-0.084)	**0.084** (0.072-0.097)	**0.097** (0.082-0.113)	**0.111** (0.092-0.129)	**0.131** (0.107-0.155)	**0.148** (0.118-0.177)
7-day	**0.019** (0.017-0.022)	**0.025** (0.022-0.029)	**0.033** (0.029-0.038)	**0.040** (0.035-0.046)	**0.050** (0.043-0.058)	**0.058** (0.050-0.067)	**0.067** (0.056-0.078)	**0.076** (0.064-0.089)	**0.090** (0.073-0.106)	**0.101** (0.081-0.120)
10-day	**0.016** (0.013-0.018)	**0.020** (0.017-0.023)	**0.027** (0.023-0.031)	**0.032** (0.028-0.037)	**0.040** (0.034-0.046)	**0.046** (0.039-0.053)	**0.053** (0.045-0.061)	**0.060** (0.050-0.070)	**0.069** (0.057-0.082)	**0.077** (0.063-0.092)
20-day	**0.010** (0.009-0.012)	**0.013** (0.012-0.015)	**0.017** (0.015-0.020)	**0.021** (0.018-0.024)	**0.026** (0.022-0.029)	**0.029** (0.025-0.033)	**0.033** (0.028-0.038)	**0.037** (0.031-0.043)	**0.043** (0.036-0.050)	**0.047** (0.039-0.056)
30-day	**0.008** (0.007-0.009)	**0.010** (0.009-0.012)	**0.014** (0.012-0.016)	**0.017** (0.015-0.019)	**0.020** (0.018-0.023)	**0.023** (0.020-0.027)	**0.026** (0.022-0.030)	**0.029** (0.025-0.034)	**0.034** (0.028-0.039)	**0.037** (0.030-0.044)
45-day	**0.007** (0.006-0.007)	**0.008** (0.007-0.010)	**0.011** (0.010-0.013)	**0.013** (0.012-0.015)	**0.016** (0.014-0.018)	**0.018** (0.016-0.021)	**0.021** (0.018-0.023)	**0.023** (0.019-0.026)	**0.026** (0.022-0.030)	**0.028** (0.023-0.033)
60-day	**0.006** (0.005-0.006)	**0.007** (0.006-0.008)	**0.010** (0.008-0.011)	**0.012** (0.010-0.013)	**0.014** (0.012-0.016)	**0.015** (0.013-0.018)	**0.017** (0.015-0.020)	**0.019** (0.016-0.021)	**0.021** (0.018-0.024)	**0.022** (0.019-0.026)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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PF graphical

APPENDIX A.2 - RAINFALL INTENSITY - ONSITE AREAS

NOAA Atlas 14, Volume 1, Version 5
Location name: Washoe Valley, Nevada, USA*
Latitude: 39.2927°, Longitude: -119.8282°
Elevation: 5092.55 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]

Duration	Average recurrence interval (years)									
	1	**2**	**5**	**10**	**25**	**50**	**100**	**200**	**500**	**1000**
5-min	**1.31** (1.13-1.55)	**1.64** (1.42-1.93)	**2.17** (1.86-2.57)	**2.69** (2.28-3.17)	**3.53** (2.90-4.19)	**4.31** (3.44-5.16)	**5.22** (4.02-6.35)	**6.34** (4.67-7.86)	**8.11** (5.62-10.3)	**9.74** (6.40-12.7)
10-min	**1.00** (0.864-1.18)	**1.25** (1.08-1.47)	**1.66** (1.42-1.96)	**2.05** (1.73-2.41)	**2.69** (2.21-3.19)	**3.28** (2.62-3.92)	**3.97** (3.05-4.83)	**4.82** (3.55-5.99)	**6.17** (4.27-7.87)	**7.42** (4.87-9.66)
15-min	**0.828** (0.712-0.976)	**1.03** (0.892-1.22)	**1.37** (1.17-1.62)	**1.69** (1.43-2.00)	**2.22** (1.83-2.63)	**2.71** (2.16-3.24)	**3.28** (2.53-3.99)	**3.98** (2.94-4.95)	**5.10** (3.53-6.50)	**6.13** (4.02-7.98)
30-min	**0.558** (0.480-0.658)	**0.694** (0.600-0.820)	**0.922** (0.786-1.09)	**1.14** (0.966-1.34)	**1.49** (1.23-1.77)	**1.82** (1.46-2.18)	**2.21** (1.70-2.69)	**2.68** (1.98-3.33)	**3.44** (2.38-4.38)	**4.13** (2.71-5.38)
60-min	**0.345** (0.297-0.407)	**0.429** (0.372-0.507)	**0.570** (0.487-0.674)	**0.705** (0.597-0.831)	**0.925** (0.762-1.10)	**1.13** (0.901-1.35)	**1.37** (1.05-1.66)	**1.66** (1.22-2.06)	**2.13** (1.47-2.71)	**2.56** (1.68-3.33)
2-hr	**0.230** (0.204-0.262)	**0.284** (0.252-0.324)	**0.361** (0.318-0.411)	**0.428** (0.372-0.486)	**0.528** (0.447-0.602)	**0.617** (0.510-0.714)	**0.720** (0.579-0.846)	**0.854** (0.664-1.04)	**1.08** (0.804-1.37)	**1.29** (0.926-1.68)
3-hr	**0.185** (0.166-0.208)	**0.230** (0.207-0.259)	**0.285** (0.255-0.321)	**0.330** (0.293-0.372)	**0.393** (0.343-0.445)	**0.447** (0.383-0.511)	**0.507** (0.426-0.586)	**0.594** (0.489-0.698)	**0.738** (0.590-0.920)	**0.873** (0.680-1.13)
6-hr	**0.131** (0.117-0.147)	**0.163** (0.146-0.184)	**0.201** (0.179-0.226)	**0.230** (0.203-0.259)	**0.269** (0.234-0.304)	**0.298** (0.256-0.339)	**0.326** (0.276-0.376)	**0.361** (0.299-0.421)	**0.413** (0.335-0.490)	**0.460** (0.366-0.572)
12-hr	**0.086** (0.077-0.097)	**0.108** (0.096-0.122)	**0.135** (0.120-0.152)	**0.156** (0.138-0.176)	**0.184** (0.160-0.209)	**0.206** (0.176-0.235)	**0.227** (0.192-0.263)	**0.249** (0.206-0.291)	**0.278** (0.224-0.332)	**0.301** (0.238-0.366)
24-hr	**0.057** (0.051-0.065)	**0.072** (0.064-0.082)	**0.091** (0.081-0.103)	**0.106** (0.094-0.120)	**0.127** (0.112-0.145)	**0.144** (0.126-0.164)	**0.162** (0.140-0.186)	**0.181** (0.154-0.209)	**0.206** (0.172-0.240)	**0.226** (0.186-0.267)
2-day	**0.034** (0.030-0.039)	**0.043** (0.038-0.050)	**0.055** (0.048-0.063)	**0.064** (0.056-0.075)	**0.078** (0.067-0.091)	**0.089** (0.076-0.104)	**0.101** (0.085-0.118)	**0.113** (0.094-0.134)	**0.130** (0.106-0.156)	**0.144** (0.115-0.175)
3-day	**0.026** (0.023-0.030)	**0.033** (0.029-0.038)	**0.043** (0.038-0.050)	**0.051** (0.045-0.059)	**0.063** (0.054-0.072)	**0.072** (0.062-0.083)	**0.082** (0.070-0.096)	**0.093** (0.078-0.109)	**0.108** (0.089-0.129)	**0.121** (0.097-0.145)
4-day	**0.023** (0.020-0.026)	**0.029** (0.025-0.033)	**0.037** (0.033-0.043)	**0.045** (0.039-0.051)	**0.055** (0.048-0.063)	**0.064** (0.055-0.073)	**0.073** (0.062-0.084)	**0.083** (0.070-0.096)	**0.098** (0.080-0.115)	**0.110** (0.089-0.130)
7-day	**0.015** (0.013-0.017)	**0.019** (0.017-0.022)	**0.025** (0.022-0.029)	**0.031** (0.027-0.035)	**0.038** (0.033-0.043)	**0.043** (0.037-0.050)	**0.050** (0.042-0.057)	**0.056** (0.047-0.065)	**0.066** (0.054-0.077)	**0.073** (0.060-0.087)
10-day	**0.012** (0.010-0.014)	**0.015** (0.013-0.017)	**0.020** (0.018-0.023)	**0.024** (0.021-0.028)	**0.030** (0.026-0.034)	**0.034** (0.029-0.039)	**0.039** (0.033-0.045)	**0.044** (0.037-0.051)	**0.051** (0.042-0.059)	**0.056** (0.046-0.066)
20-day	**0.008** (0.007-0.009)	**0.010** (0.009-0.011)	**0.013** (0.011-0.015)	**0.015** (0.014-0.017)	**0.019** (0.016-0.021)	**0.021** (0.019-0.024)	**0.024** (0.021-0.027)	**0.027** (0.023-0.031)	**0.031** (0.026-0.036)	**0.034** (0.028-0.039)
30-day	**0.006** (0.005-0.007)	**0.008** (0.007-0.009)	**0.010** (0.009-0.012)	**0.012** (0.011-0.014)	**0.015** (0.013-0.017)	**0.017** (0.014-0.019)	**0.019** (0.016-0.021)	**0.021** (0.018-0.024)	**0.024** (0.020-0.028)	**0.026** (0.022-0.030)
45-day	**0.005** (0.004-0.005)	**0.006** (0.005-0.007)	**0.008** (0.007-0.009)	**0.010** (0.008-0.011)	**0.012** (0.010-0.013)	**0.013** (0.011-0.015)	**0.014** (0.013-0.016)	**0.016** (0.014-0.018)	**0.018** (0.015-0.020)	**0.019** (0.016-0.022)
60-day	**0.004** (0.004-0.005)	**0.005** (0.005-0.006)	**0.007** (0.006-0.008)	**0.008** (0.007-0.009)	**0.010** (0.009-0.011)	**0.011** (0.009-0.012)	**0.012** (0.010-0.014)	**0.013** (0.011-0.015)	**0.014** (0.012-0.017)	**0.015** (0.013-0.018)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) values and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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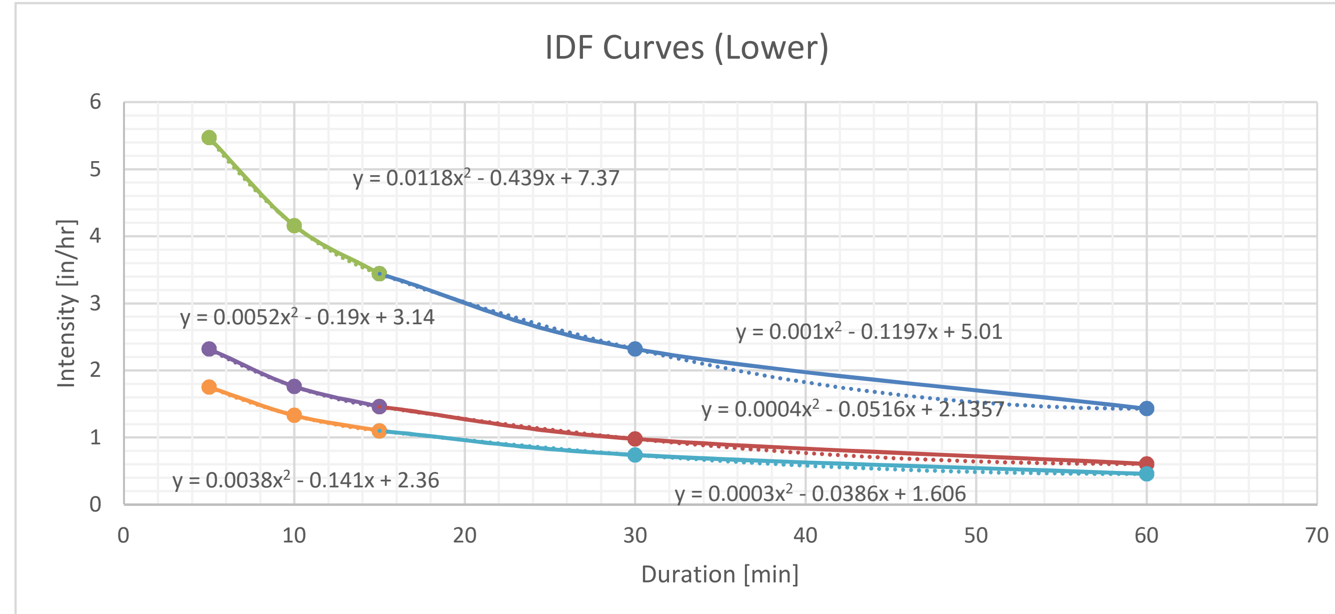
PF graphical

APPENDIX B

- HYDROLOGIC CALCULATIONS

OPHIR HILL SUBDIVISION HYDROLOGY - NDOT 36" CULVERT INFLOW

		Subbasin ID	E_1
		Drainage Direction	Overall
		Area, A [sf]	2116822.5
		Area, A [ac]	48.60
Coef.	C	Composite C_5	0.20
		Composite C_{100}	0.50
Initial Overland	T_i	Flow Runoff Coefficient, C_5 "R"	0.05
		Flow Length, L [ft] [1]	500
		Land Slope, s [%]	20.00
		Initial Overland Time: T_i [min]	15.57
Travel Time	T_t	Flow Length, L [ft]	3120
		Channel Slope, s [%]	5.13
		Travel Time Coefficient [3]	1.50
		Average Velocity, V_5 [ft/s]	3.40
		Travel Time: T_t [min]	15.31
ToC & Intensity	T_c	Time of Concentration, T_c [min]	30.88
	Urban. Check	Required? - Y/N	Y
		Total Length: L_{total} [ft]	3620
		Time of Concentration, Check, $T_{c,check}$ [min]	30.1
	$T_{c,final}$	**Final ToC, $T_{c,final}$ [min]**	**30.11**
	I [2]	2-yr Intensity I_2 [in/hr]	0.72
		5-yr Intensity I_5 [in/hr]	0.94
		100-yr Intensity I_{100} [in/hr]	2.31
Flow	Q	2-yr Flow, Q_2 [cfs]	6.96
		5-yr Flow, Q_5 [cfs]	9.18
		Design 100-yr Flow, Q_{100} [cfs]	**56.19**



NOAA Intensity [in/hr]			
Lat: 39.2977°, Long: -119.8413°			
Elevation: 5621.51 ft (USGS)			
Duration [min]	I_2 [in/hr]	I_5 [in/hr]	I_{100} [in/hr]
5	1.75	2.32	5.47
10	1.33	1.76	4.16
15	1.1	1.46	3.44
30	0.74	0.98	2.32
60	0.458	0.607	1.43

OPHIR HILL SUBDIVISION RUNOFF COEFFICIENTS - PRE-DEVELOPMENT

Landcover Classification	C_5	C_{100}
Pavement	0.88	0.93
Roof	0.85	0.87
Gravel	0.25	0.50
Lawn/Landscape	0.05	0.30
Desert	0.20	0.50
Cleared Land	0.35	0.45

Subbasin ID	**A1**	**A2**	**A3**	**B1**	**B2**	**Onsite Total**	**Offsite Total**	**Total to BLM**	**Onsite Only to BLM**
Drainage Direction	From 046-032-01	From NDOT	From 046-032-08	To BLM	To 046-032-06		Onto Project Site	To BLM	To BLM
Area, A [ac]	**3.13**	**0.23**	**0.05**	**10.76**	**0.53**	**11.29**	**3.41**	**14.17**	**10.76**

Composite Areas [ac]		A1	A2	A3	B1	B2	Onsite Total	Offsite Total	Total to BLM	Onsite Only to BLM
	Pavement	0.13	0.08					0.21	0.21	
	Roof	0.06			0.07		0.07	0.06	0.13	0.07
	Gravel	0.51						0.51	0.51	
	Lawn/Landscape	2.43						2.43	2.43	
	Desert		0.15	0.05				0.20	0.20	
	Cleared Land				10.69	0.53	11.22		10.69	10.69

	A1	A2	A3	B1	B2	Onsite Total	Offsite Total	Total to BLM	Onsite Only to BLM
Area Check	✓	✓	✓	✓	✓	✓	✓	✓	✓

	A1	A2	A3	B1	B2	Onsite Total	Offsite Total	Total to BLM	Onsite Only to BLM
Composite C_5	**0.13**	**0.44**	**0.20**	**0.35**	**0.35**	**0.35**	**0.15**	**0.31**	**0.35**
Composite C_{100}	**0.37**	**0.65**	**0.50**	**0.45**	**0.45**	**0.45**	**0.39**	**0.44**	**0.45**

OPHIR HILL SUBDIVISION HYDROLOGY - PRE-DEVELOPMENT

		Subbasin ID	A1	A2	A3	B1	B2	Onsite Total	Offsite Total	Total to BLM	Onsite Only to BLM
		Drainage Direction	From 046-032-01	From NDOT	From 046-032-08	To BLM	To 046-032-06		Onto Project Site	To BLM	To BLM
		Area, A [sf]	136342.8	10018.8	2178	468705.6	23086.8	491792.4	148539.6	617245.2	468705.6
		Area, A [ac]	3.13	0.23	0.05	10.76	0.53	11.29	3.41	14.17	10.76
Coef.	C	Composite C_5	0.13	0.44	0.20	0.35	0.35	0.35	0.15	0.31	0.35
		Composite C_{100}	0.37	0.65	0.50	0.45	0.45	0.45	0.39	0.44	0.45
Initial Overland	T_i	Flow Runoff Coefficient, C_5 "R"	0.13	0.44	0.20	0.35	0.35	0.35	0.13	0.31	0.35
		Flow Length, L [ft] [1]	415	45	18	500	133	500	415	415	500
		Elevation Change	20	2	6	20	12	36.4	20	20	36.4
		Land Slope, s [%]	4.82	4.44	33.33	4.00	9.02	7.28	4.82	4.82	7.28
		Initial Overland Time: T_i [min]	21.06	4.85	2.14	19.02	7.48	15.58	21.06	17.15	15.58
Travel Time	T_t	Flow Length, L [ft]	0	53	0	112	244	399	0	616	399
		Elevation Change		5.9		2.2	14.5	6		22	6
		Channel Slope, s [%]	-	11.13	-	1.96	5.94	1.50	-	3.57	1.50
		Average Velocity, V_5 [ft/s] [3]		2.80		1.50	2.50	2.20	0.00	2.20	2.20
		Travel Time: T_t [min]	0.00	0.32	0.00	1.24	1.63	3.02	0.00	1.90	3.02
ToC & Intensity	T_c	Time of Concentration, T_c [min]	21.06	5.16	2.14	20.26	9.11	18.60	21.06	19.05	18.60
	Urban. Check	Required? - Y/N	N	N	N	N	N	N	N	N	N
		Total Length: L_{total} [ft]	-	-	-	-	-	-	-	-	-
		Time of Concentration, Check, $T_{c,check}$ [min]	-	-	-	-	-	-	-	-	-
	$T_{c,final}$	**Final ToC, $T_{c,final}$ [min]**	**21.06**	**10.00**	**10.00**	**20.26**	**10.00**	**18.60**	**21.06**	**19.05**	**18.60**
	I [2]	2-yr Intensity I_2 [in/hr]	0.88	1.17	1.17	0.90	1.17	0.94	0.88	0.92	0.94
		5-yr Intensity I_5 [in/hr]	1.17	1.66	1.66	1.19	1.66	1.24	1.17	1.23	1.24
		100-yr Intensity I_{100} [in/hr]	2.81	3.97	3.97	2.87	3.97	3.00	2.81	2.96	3.00
Flow	Q	2-yr Flow, Q_2 [cfs] **	0.36	0.12	0.01	3.40	0.22	3.73	0.46	4.00	3.56
		5-yr Flow, Q_5 [cfs] **	0.48	0.17	0.02	4.53	0.31	4.96	0.61	5.32	4.73
		**100-yr Flow, Q_{100} [cfs] ** **	**3.25**	**0.59**	**0.10**	**13.98**	**0.95**	**15.31**	**3.74**	**18.37**	**14.59**

[1] Maximum of 500 feet
[2] From NOAA Atlas 14
[3] From Figure 701 TMRDM

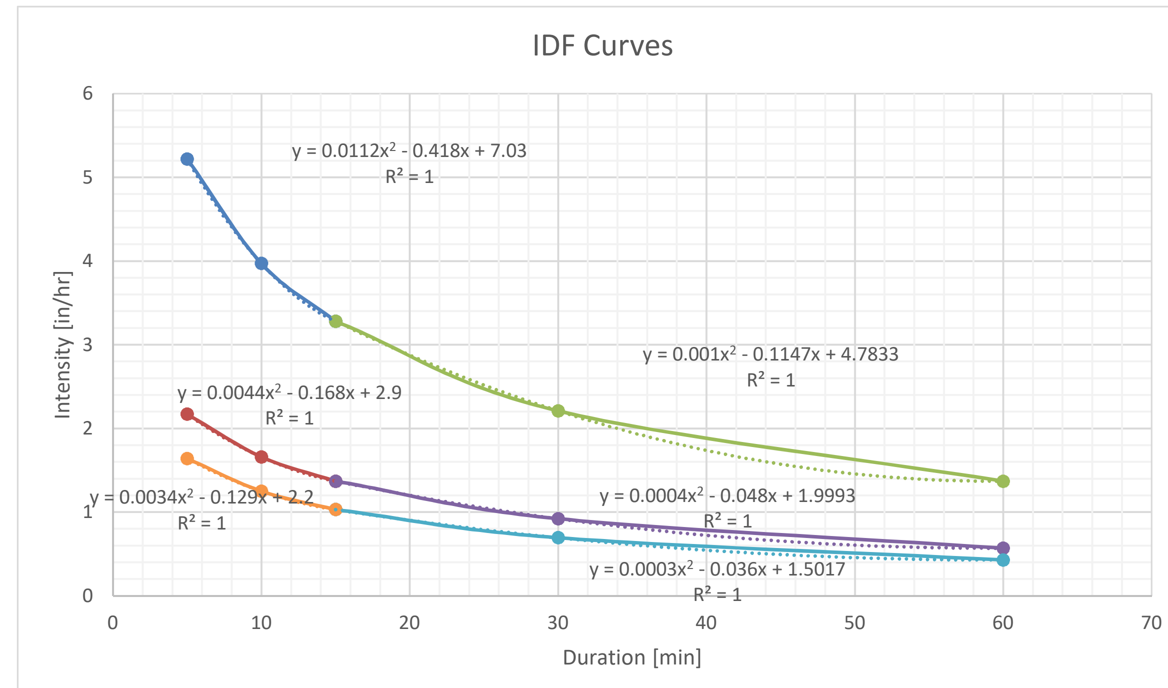
OPHIR HILL SUBDIVISION HYDROLOGY - PRE-DEVELOPMENT

$$T_i = \frac{1.8(1.1 - R)L_o^{1/2}}{s^{1/3}} \qquad T_t = \frac{L}{60V}$$

$$T_{c,check} = \frac{L_{total}}{180} + 10$$

**Coefficients from IDF regression curves must be manually updated in these columns.

NOAA Intensity [in/hr]			
Lat: 39.2927°, Long: -119.8282°			
Elevation: 5092.55 ft (USGS)			
Duration [min]	I2 [in/hr]	I5 [in/hr]	I100 [in/hr]
5	1.64	2.17	5.22
10	1.25	1.66	3.97
15	1.03	1.37	3.28
30	0.694	0.922	2.21
60	0.429	0.57	1.37



OPHIR HILL SUBDIVISION RUNOFF COEFFICIENTS - PROPOSED

Landcover Classification	C_5	C_{100}
Pavement	0.88	0.93
Roof	0.85	0.87
Gravel	0.25	0.50
Lawn/Landscape	0.05	0.30
Desert	0.20	0.50
Cleared Land	0.35	0.45

	Subbasin ID	**C1**	**C2**	**C3**	**D1**	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**	**D8**	**D9**	**D10**	**Onsite Total**	**Total to BLM Un-Detained**	**Offsite Total**	**Total to Det. Pond**	**Onsite Only to BLM Un-Detained**
	Drainage Direction	From 046-032-01	From NDOT	From 046-032-08	To BLM Direct	To Culvert 1	To Pond (Parcel D Middle)	To Pond (Parcel D South)	To South Swale on Parcel C	To Pond (Parcel D North)	To North Culvert on Parcel C	To Pond (Parcel B South)	To 046-032-06	To Pond (Parcel B North)	Onsite Total	Total to BLM Un-detained	Onto Project Site	To Detention Pond	Onsite Only Undetained to BLM
	Area, A [ac]	**3.14**	**0.23**	**0.04**	**2.14**	**0.22**	**1.23**	**0.49**	**0.86**	**0.75**	**2.36**	**0.71**	**0.03**	**2.59**	**11.38**	**5.32**	**3.41**	**9.44**	**2.14**
Composite Areas [ac]	Pavement	0.23	0.10				0.42			0.12	0.09	0.07		0.18	0.88	0.23	0.33	0.98	
	Roof	0.09					0.04	0.04	0.04	0.04	0.08			0.12	0.36	0.09	0.09	0.36	
	Gravel	0.46														0.46	0.46		
	Lawn/Landscape	2.36			0.01		0.01	0.04	0.04		0.08			0.08	0.26	2.37	2.36	0.25	0.01
	Desert		0.13	0.04	2.13	0.22	0.76	0.41	0.78	0.59	2.11	0.64	0.03	2.21	9.88	2.17	0.17	7.85	2.13
	Cleared Land																		
	Area Check	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
	Composite C_5	**0.16**	**0.50**	**0.20**	**0.20**	**0.20**	**0.45**	**0.24**	**0.22**	**0.34**	**0.24**	**0.27**	**0.20**	**0.27**	**0.27**	**0.18**	**0.19**	**0.29**	**0.20**
	Composite C_{100}	**0.39**	**0.69**	**0.50**	**0.50**	**0.50**	**0.66**	**0.51**	**0.51**	**0.59**	**0.52**	**0.54**	**0.50**	**0.54**	**0.54**	**0.44**	**0.41**	**0.55**	**0.50**

OPHIR HILL SUBDIVISION HYDROLOGY - PROPOSED

		Subbasin ID	C1	C2	C3	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	Onsite Total	Total to BLM Un-Detained	Offsite Total	Total to Det. Pond	Onsite Only to BLM Un-Detained
		Drainage Direction	From 046-032-01	From NDOT	From 046-032-08	To BLM Direct	To Culvert 1	To Pond (Parcel D Middle)	To Pond (Parcel D South)	To South Swale on Parcel C	To Pond (Parcel D North)	To North Culvert on Parcel C	To Pond (Parcel B South)	To 046-032-06	To Pond (Parcel B North)	Onsite Total	Total to BLM Un-detained	Onto Project Site	To Detention Pond	Onsite Only Undetained to BLM
		Area, A [sf]	136778.4	10018.8	1742.4	93218.4	9583.2	53578.8	21344.4	37461.6	32670	102801.6	30927.6	1306.8	112820.4	495712.8	231739.2	148539.6	411206.4	93218.4
		Area, A [ac]	3.14	0.23	0.04	2.14	0.22	1.23	0.49	0.86	0.75	2.36	0.71	0.03	2.59	11.38	5.32	3.41	9.44	2.14
Coef.	C	Composite C_5	0.16	0.50	0.20	0.20	0.20	0.45	0.24	0.22	0.34	0.24	0.27	0.20	0.27	0.27	0.18	0.19	0.29	0.20
		Composite C_{100}	0.39	0.69	0.50	0.50	0.50	0.66	0.51	0.51	0.59	0.52	0.54	0.50	0.54	0.54	0.44	0.41	0.55	0.50
Initial Overland	T_i	Flow Runoff Coefficient, C_5 "R"	0.16	0.50	0.20	0.20	0.20	0.88	0.24	0.22	0.34	0.24	0.27	0.20	0.27	0.27	0.18	0.19	0.20	0.20
		Flow Length, L [ft] [1]	357	54	16	290	122	32	220	175	0	245	173	71	216	173	290	357	173	290
		Elevation Change	24	2.5	6	12	9	1.2	6	6.5	0	25	3.5	6	25	3.5	12	24	3.5	12
		Land Slope, s [%]	6.72	4.63	37.50	4.14	7.38	3.75	2.73	3.71	-	10.20	2.02	8.45	11.57	2.02	4.14	6.72	2.02	4.14
		Initial Overland Time: T_i [min]	16.94	4.76	1.94	17.18	9.19	1.44	16.43	13.53	0.00	11.17	15.54	6.70	9.71	15.54	17.57	16.40	16.85	17.18
Travel Time	T_t	Flow Length, L [ft]		50				660	147	35	256	275	133	0	821	133	0	0	133	
		Elevation Change		4.5				25.6	1.5	0.7	7	4.5	1.33		13	1.33			1.33	
		Channel Slope, s [%]	-	9.00	-	-	-	3.88	1.02	2.00	2.73	1.64	1.00	-	1.58	1.00	-	-	1.00	-
		Average Velocity, V_5 [ft/s] [3]		2.20				2.52	1.47	2.08	2.42	1.88	1.47	0.00	2.11	1.47	0.00	0.00	1.47	
		Travel Time: T_t [min]	0.00	0.38	0.00	0.00	0.00	4.37	1.67	0.28	1.76	2.44	1.51	0.00	6.48	1.51	0.00	0.00	1.51	0.00
ToC & Intensity	T_c	Time of Concentration, T_c [min]	16.94	5.14	1.94	17.18	9.19	5.81	18.10	13.81	1.76	13.61	17.04	6.70	16.19	17.05	17.57	16.40	18.36	17.18
	Urban. Check	Required? - Y/N	N	N	N	N	N	N	N	Y	Y	Y	Y	N	Y	Y	N	N	Y	N
		Total Length: L_{total} [ft]	-	-	-	-	-	-	-	210	256	520	306	-	1037	306	-	-	306	-
		Time of Concentration, Check, $T_{c,check}$ [min]	-	-	-	-	-	-	-	11.2	11.4	12.9	11.7	-	15.8	11.7	-	-	11.7	-
	$T_{c,final}$	**Final ToC, $T_{c,final}$ [min]**	**16.94**	**10.00**	**10.00**	**17.18**	**10.00**	**10.00**	**18.10**	**11.17**	**5.00**	**12.89**	**11.70**	**10.00**	**15.76**	**11.70**	**17.57**	**16.40**	**11.70**	**17.18**
	I [2]	2-yr Intensity I_2 [in/hr]	0.98	1.17	1.17	0.97	1.17	1.17	0.95	1.18	1.64	1.10	1.16	1.17	1.01	1.16	0.96	0.99	1.16	0.97
		5-yr Intensity I_5 [in/hr]	1.30	1.66	1.66	1.29	1.66	1.66	1.26	1.57	2.17	1.47	1.54	1.66	1.34	1.54	1.28	1.32	1.54	1.29
		100-yr Intensity I_{100} [in/hr]	3.13	3.97	3.97	3.11	3.97	3.97	3.03	3.76	5.22	3.50	3.67	3.97	3.22	3.67	3.08	3.17	3.67	3.11
Flow	Q	2-yr Flow, Q_2 [cfs] **	0.50	0.13	0.01	0.41	0.05	0.65	0.11	0.23	0.42	0.63	0.22	0.01	0.71	3.55	0.91	0.63	3.18	0.41
		5-yr Flow, Q_5 [cfs] **	0.67	0.19	0.01	0.55	0.07	0.92	0.15	0.30	0.56	0.84	0.29	0.01	0.95	4.72	1.21	0.84	4.23	0.55
		100-yr Flow, Q_{100} [cfs] **	**3.85**	**0.63**	**0.08**	**3.32**	**0.44**	**3.21**	**0.76**	**1.64**	**2.30**	**4.32**	**1.41**	**0.06**	**4.52**	**22.58**	**7.13**	**4.47**	**19.19**	**3.32**

[1] Maximum of 500 feet
[2] From NOAA Atlas 14
[3] From Figure 701 TMRDM

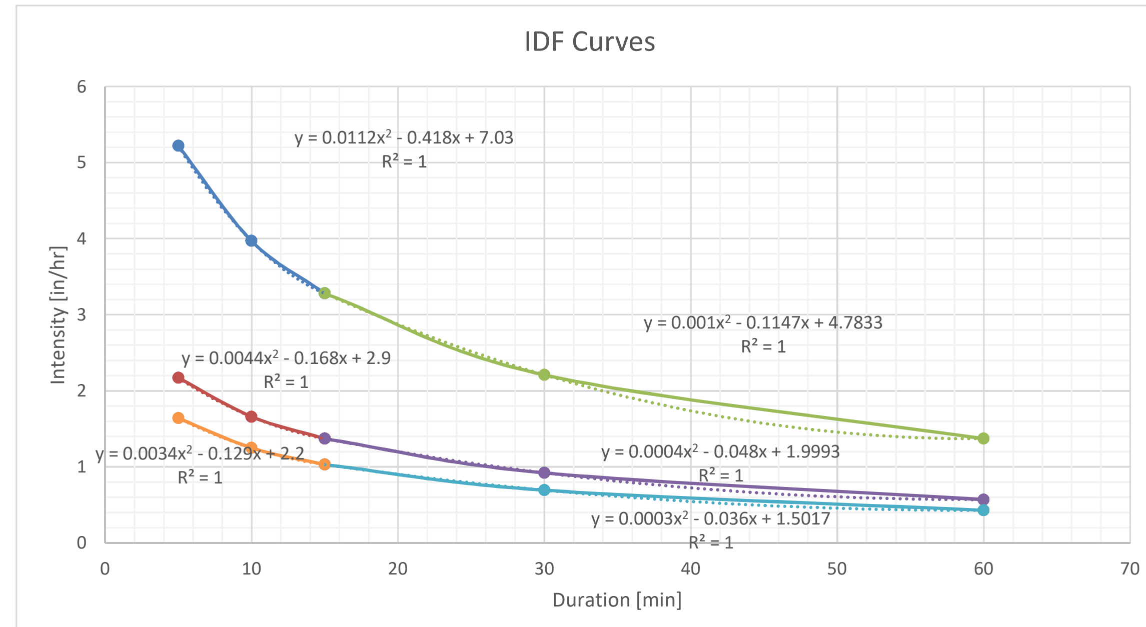
OPHIR HILL SUBDIVISION HYDROLOGY - PROPOSED

$$T_i = \frac{1.8(1.1 - R)L_o^{1/2}}{S^{1/3}} \qquad T_t = \frac{L}{60V}$$

$$T_{c,check} = \frac{L_{total}}{180} + 10$$

**Coefficients from IDF regression curves must be manually updated in these columns.

NOAA Intensity [in/hr]			
Lat: 39.2927°, Long: -119.8282°			
Elevation: 5092.55 ft (USGS)			
Duration [min]	I2 [in/hr]	I5 [in/hr]	I100 [in/hr]
5	1.64	2.17	5.22
10	1.25	1.66	3.97
15	1.03	1.37	3.28
30	0.694	0.922	2.21
60	0.429	0.57	1.37



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Client: BOULDER CREEK Sheet 1 of ~~22~~
Description: OPHIR HILL HYDROLOGY
Job No. 9103.003
By: ECT Date: 4-26-23
Checked By: Date:

ESTIMATE OVERLAND FLOW IN SWALES FOR TC CALCULATIONS USING MANNING'S EQUATION

AREA D3 - SWALE IN MIDDLE OF PARCEL D

OVERLAND FLOW IS PARTIALLY IN GUTTER AND PARTIALLY IN SHALLOW SWALE
DETERMINE COMBINED FLOW TIME AND AVERAGE OVER THE FULL LENGTH.

GUTTER FLOW: $L = 395\text{FT}$
$S \cong 19/395 = 4.81\%$
$n = 0.013$
$V = 3.75 \text{ FT/s}$

SWALE:

ASSUME: EARTH SWALE
$n = 0.035$
V-DITCH W/5:1 SIDE SLOPES

$L = 265\text{FT}$
$S = 6.6/265 \cong 2.5\%$
$V = 1.70 \text{ fps}$

TRAVEL TIME $= (395\text{FT}/3.75\text{FT/s}) + (265\text{F}/1.70\text{FT/s})$
$= 261.2\text{s}$

AVG VELOCITY $= (395\text{FT} + 265\text{FT})/261.2\text{SEC}$
$= 2.52 \text{ FT/s}$

AREA D4 - SWALE ON SOUTH SIDE OF PARCEL D

SAME ASSUMPTIONS AS D3 ABOVE

$S = 1\%$
$L = 147\text{FT}$

$V = 1.47 \text{ FT/s}$

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Client: BOULDER CREEK Sheet 2 of ~~22~~

Description: OPHIR HILL HYDROLOGY

Job No. 9108.003

By: ECT Date: 4-26-23

Checked By: Date:

AREA D-5 - SOUTH SWALE PARCEL C

SAME ASSUMPTIONS AS D3 ABOVE

S = 2%,
L = 35'
V ≈ 2.08 FT/s

AREA D-6 - SWALE ON NORTH SIDE OF PARCEL D

L = 256 FT
ELEV = 7 FT
S = 2.73%

V = 2.42 FT/s

AREA D7 - SWALE TO NORTH CULVERT ON PARCEL C

L = 275 FT
ELEV = 4.5'
SLOPE = 1.64%

V = 1.88 FT/s

AREA D-8 - SOUTH SWALE ON PARCEL C

S = 1%
V = 1.47 FT/s

AREA D-10 - NORTH SWALE PARCEL C

S = 1.58%

V = 1.85 FT/s

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Client: BOULDER CREEK Sheet 3 of ~~22~~

Description: OPHIR HILL HYDROLOGY

Job No. 9103.003

By: ECT Date: 4-27-23

Checked By: Date:

SIZE COLLECTION SWALES & CULVERTS

PARCEL D MIDDLE SWALE

COMBINATION OF AREAS D2 & D3

$A = 1.45$ ac
$C_5 = 0.41$
$C_{100} = 0.63$

$Q_5 = 0.96$ $V_5 = 2.63$ fps
$Q_{100} = 3.50$

CULVERT 1 (AREA D2)

$Q_5 = 0.07$ cfs

$Q_{100} = 0.44$ cfs

12" PVC

100-YR HW DEPTH = 0.36 FT

AVAILABLE HW = 2.0 FT OK

Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Apr 27 2023

CULVERT 1 - 100-YEAR

Invert Elev Dn (ft)	= 5083.00
Pipe Length (ft)	= 65.00
Slope (%)	= 3.23
Invert Elev Up (ft)	= 5085.10
Rise (in)	= 12.0
Shape	= Circular
Span (in)	= 12.0
No. Barrels	= 1
n-Value	= 0.013
Culvert Type	= Circular Concrete
Culvert Entrance	= Groove end projecting (C)
Coeff. K,M,c,Y,k	= 0.0045, 2, 0.0317, 0.69, 0.2

Embankment

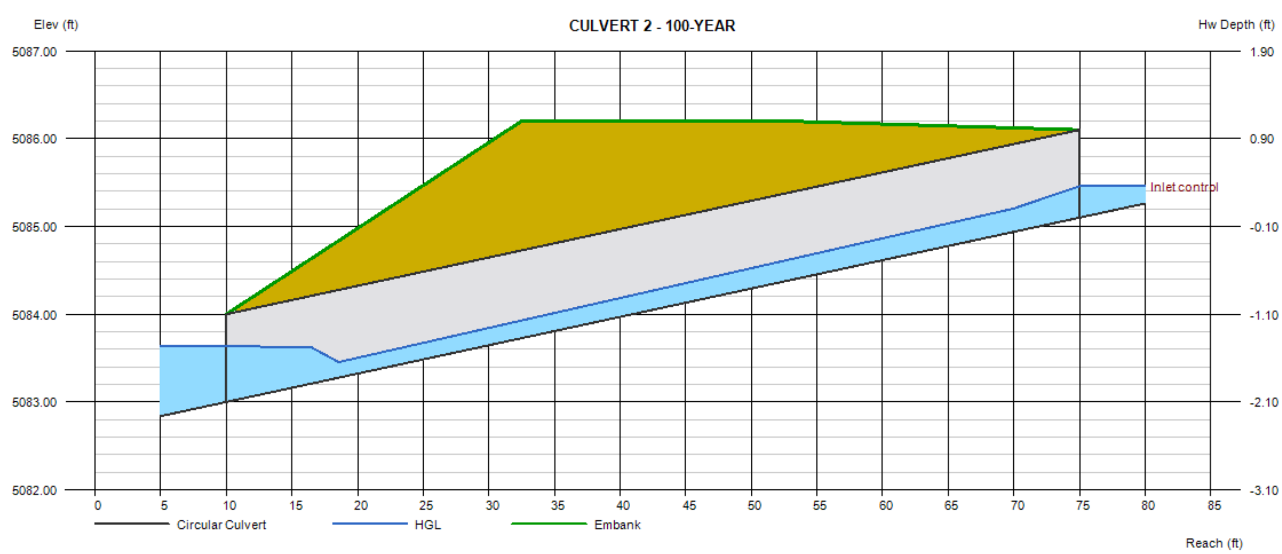
Top Elevation (ft)	= 5086.20
Top Width (ft)	= 20.00
Crest Width (ft)	= 50.00

Calculations

Qmin (cfs)	= 0.40
Qmax (cfs)	= 0.45
Tailwater Elev (ft)	= (dc+D)/2

Highlighted

Qtotal (cfs)	= 0.44
Qpipe (cfs)	= 0.44
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 0.83
Veloc Up (ft/s)	= 2.52
HGL Dn (ft)	= 5083.64
HGL Up (ft)	= 5085.38
Hw Elev (ft)	= 5085.46
Hw/D (ft)	= 0.36
Flow Regime	= Inlet Control



Parcel D Middle Swale (D2+D3)

Shape	Triangular	
Solve For	Depth of Flow	
Flow Rate	0.96	cfs
Max. Flow	29.24	cfs
% Full	27	%
Velocity	2.63	fps
Left Side Z	5	
Right Side Z	5	
Channel Depth	1	ft
Depth of Flow	0.27	ft
Slope	0.0249	ft/ft
Manning's n:		
Channel Composite	0.025	
Left Side		
Right Side		
Area	0.36	sf
Top Width	2.7	ft
Wetted Perimeter	2.75	ft
Hydraulic Radius	0.13	ft
Froude Number	1.26	
Flow State	SuperCritical	
Critical Slope	0.0176	ft/ft
Critical Depth	0.3	ft
Critical Velocity	2.19	fps

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Client: BOULDER CREEK Sheet 6 of ~~22~~

Description: OPHIR HILL HYDROLOGY

Job No. 9103.003

By: ELT Date: 4-27-23

Checked By: Date:

CULVERT 2 (AREA D5)

Q_S = 0.30 cfs

Q_{100} = 1.64 cfs

12" PVC

AVAILABLE HW = 2.43 FT

100-YR HW DEPTH = 0.67 FT OK

PARCEL D NORTH SWALE

COMBINATION OF AREAS D5 & D6

A = 1.61 ac

C_S = 0.28

C_{100} = 0.55

Q_S = 0.61 cfs

Q_{100} = 2.86 cfs

V_S = 2.31 fps

Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Apr 27 2023

CULVERT 2 - 100-YEAR

Invert Elev Dn (ft)	=	5083.00
Pipe Length (ft)	=	62.00
Slope (%)	=	1.77
Invert Elev Up (ft)	=	5084.10
Rise (in)	=	12.0
Shape	=	Circular
Span (in)	=	12.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Groove end projecting (C)
Coeff. K,M,c,Y,k	=	0.0045, 2, 0.0317, 0.69, 0.2

Embankment

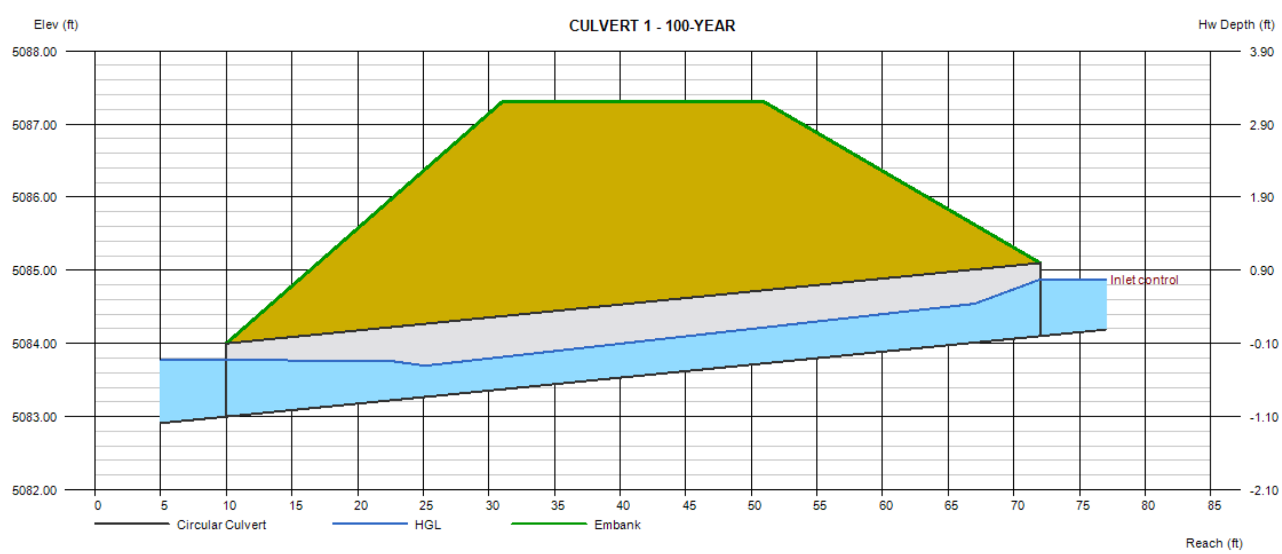
Top Elevation (ft)	=	5087.30
Top Width (ft)	=	20.00
Crest Width (ft)	=	50.00

Calculations

Qmin (cfs)	=	1.60
Qmax (cfs)	=	1.65
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	1.64
Qpipe (cfs)	=	1.64
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	2.52
Veloc Up (ft/s)	=	3.76
HGL Dn (ft)	=	5083.77
HGL Up (ft)	=	5084.64
Hw Elev (ft)	=	5084.87
Hw/D (ft)	=	0.77
Flow Regime	=	Inlet Control



Parcel D Middle Swale (D2+D3)

Shape	Triangular	
Solve For	Depth of Flow	
Flow Rate	0.96	cfs
Max. Flow	29.24	cfs
% Full	27	%
Velocity	2.63	fps
Left Side Z	5	
Right Side Z	5	
Channel Depth	1	ft
Depth of Flow	0.27	ft
Slope	0.0249	ft/ft
Manning's n:		
Channel Composite	0.025	
Left Side		
Right Side		
Area	0.36	sf
Top Width	2.7	ft
Wetted Perimeter	2.75	ft
Hydraulic Radius	0.13	ft
Froude Number	1.26	
Flow State	SuperCritical	
Critical Slope	0.0176	ft/ft
Critical Depth	0.3	ft
Critical Velocity	2.19	fps

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Client: BOULDER CREEK Sheet 9 of ~~22~~
Description: OPHIR HILL HYDROLOGY
Job No. 9103.003
By: ECT Date: 4-27-23
Checked By: Date:

CULVERT 3 (AREA D7)

$Q_5 = 0.84$ cfs
$Q_{100} = 4.52$ cfs

12" PVC

AVAILABLE HW = 3.90 FT

100-YR HW DEPTH = 1.64 FT OK

PARCEL B SOUTH SWALE (AREA D7 + D8)

$A = 3.07$ ac

$C_5 = 0.25$
$C_{100} = 0.53$

$Q_5 = 1.00$ cfs
$Q_{100} = 5.08$ cfs

$V_5 = 1.84$ fps

Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Apr 27 2023

CULVERT 3 - 100-YEAR

Invert Elev Dn (ft)	=	5082.50
Pipe Length (ft)	=	62.00
Slope (%)	=	2.42
Invert Elev Up (ft)	=	5084.00
Rise (in)	=	12.0
Shape	=	Circular
Span (in)	=	12.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Groove end projecting (C)
Coeff. K,M,c,Y,k	=	0.0045, 2, 0.0317, 0.69, 0.2

Embankment

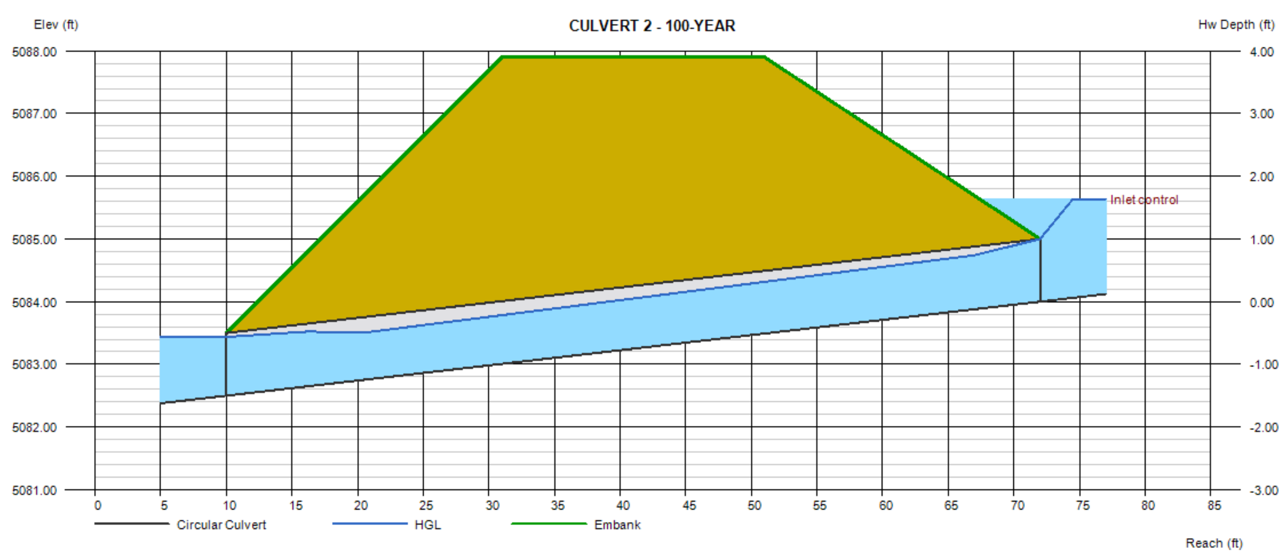
Top Elevation (ft)	=	5087.90
Top Width (ft)	=	20.00
Crest Width (ft)	=	50.00

Calculations

Qmin (cfs)	=	4.30
Qmax (cfs)	=	4.35
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	4.32
Qpipe (cfs)	=	4.32
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	5.65
Veloc Up (ft/s)	=	5.94
HGL Dn (ft)	=	5083.44
HGL Up (ft)	=	5084.87
Hw Elev (ft)	=	5085.64
Hw/D (ft)	=	1.64
Flow Regime	=	Inlet Control



Parcel B South Swale (D7 + D8)

Shape	Triangular	
Solve For	Depth of Flow	
Flow Rate	1	cfs
Max. Flow	18.53	cfs
% Full	33	%
Velocity	1.84	fps
Left Side Z	5	
Right Side Z	5	
Channel Depth	1	ft
Depth of Flow	0.33	ft
Slope	0.01	ft/ft
Manning's n:		
Channel Composite	0.025	
Left Side		
Right Side		
Area	0.54	sf
Top Width	3.3	ft
Wetted Perimeter	3.37	ft
Hydraulic Radius	0.16	ft
Froude Number	0.8	
Flow State	SubCritical	
Critical Slope	0.0175	ft/ft
Critical Depth	0.3	ft
Critical Velocity	2.2	fps

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Client: BOULDER CREEK Sheet 12 of ~~22~~
Description: OPNIE HILL HYDROLOGY
Job No. 9103.003
By: ECT Date: 4-27-23
Checked By: Date:

PARCEL B NORTH SWALE (AREA D10)

$Q_5 = 0.95$ cfs

$Q_{100} = 4.52$ cfs

$V_5 = 2.11$ fps

Parcel B North (D10)

Shape	Triangular	
Solve For	Depth of Flow	
Flow Rate	0.95	cfs
Max. Flow	23.29	cfs
% Full	30	%
Velocity	2.11	fps
Left Side Z	5	
Right Side Z	5	
Channel Depth	1	ft
Depth of Flow	0.3	ft
Slope	0.0158	ft/ft
Manning's n:		
Channel Composite	0.025	
Left Side		
Right Side		
Area	0.45	sf
Top Width	3	ft
Wetted Perimeter	3.06	ft
Hydraulic Radius	0.15	ft
Froude Number	0.96	
Flow State	SubCritical	
Critical Slope	0.0176	ft/ft
Critical Depth	0.3	ft
Critical Velocity	2.18	fps

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Client: BOULDER CREEK Sheet ~~15~~ of ~~22~~
Description: OPHIR HILL HYDROLOGY
Job No. 9105.003
By: ECT Date: 4-26-23
Checked By: Date:

DETENTION REQUIREMENT

EXISTING CONDITIONS

AREA DRAINING TO PRIVATE PROPERTY TO NORTH OF SITE (AREA B2) : $A = 0.53ac$
$T_C = 10min$
$i_5 = 1.66$ IN/HR
$i_{100} = 3.97$ IN/HR

$Q_5 = 0.31cfs$
$Q_{100} = 0.95cfs$

TOTAL ONSITE ONLY TO BLM: $A = 10.76ac$
$T_C = 18.60min$
$i_5 = 1.24$ IN/HR
$i_{100} = 3.00$ IN/HR

$Q_5 = 4.73$ cfs
$Q_{100} = 14.59$ cfs

TOTAL (ONSITE + OFFSITE) TO BLM: $A = 14.17ac$
$T_C = 19.05min$
$i_5 = 1.24$ IN/HR
$i_{100} = 3.00$ IN/HR

$Q_5 = 5.32$ cfs
$Q_{100} = 18.37$ cfs

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Client: Boulder Creek

Description: Ophir Hill Hydrology
Job No. 9103.068
By: ECT Date: 4-26-23
Checked By: Date:

Proposed Conditions

Area draining to private property north of site (Area D9): $A = 0.03\,ac$, $T_C = 10\,min$, $i_5 = 1.66\,in/hr$, $i_{100} = 3.97\,in/hr$

$Q_5 = 0.01\,cfs$
$Q_{100} = 0.06\,cfs$
} Reduction from existing

Total onsite only to BLM (undetained): $A = 2.14\,ac$, $T_C = 17.18\,min$, $i_5 = 1.29\,in/hr$, $i_{100} = 3.11\,in/hr$

$Q_5 = 0.55\,cfs$
$Q_{100} = 3.32\,cfs$

Total (offsite + onsite) to BLM (undetained):

$A = 5.32\,ac$
$T_c = 17.57\,min$
$i_5 = 1.28\,in/hr$
$i_{100} = 3.08\,in/hr$

$Q_5 = 1.21\,cfs$
$Q_{100} = 7.13\,cfs$

Total to detention pond: $A = 9.44\,ac$, $T_C = 11.70\,min$, $i_5 = 1.54\,in/hr$, $i_{100} = 3.67\,in/hr$

$Q_5 = 4.23\,cfs$
$Q_{100} = 19.19\,cfs$

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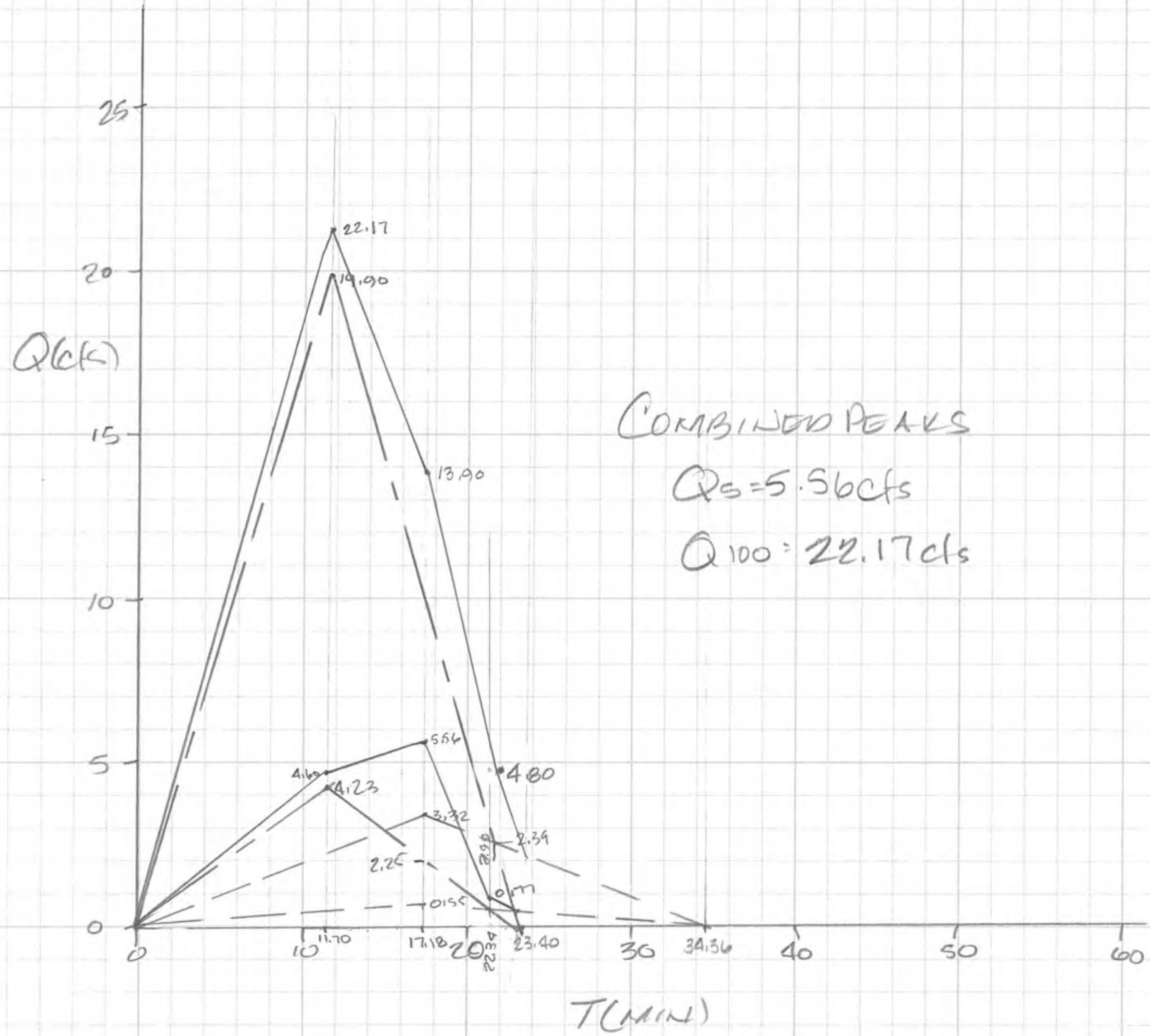
Client: BOULDER CREEK Sheet ~~17~~ of ~~22~~
Description: OPHIR HILL HYDROLOGY
Job No. 9103.003
By: ECT Date: 4-26-23
Checked By: Date:

ADD 5-YEAR AND 100-YEAR HYDROGRAPHS TO DETERMINE PEAK PRE-DETENTION FLOW TO BLM



= UNDETAINED TO BLM (ONSITE ONLY)
= POND INFLOW
= TOTAL PROPOSED (PRE-DETENTION)

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Client: BOULDER CREEK

Description: OPHIR HILL HYDROLOGY
Job No. 9103.003
By: ECT
Date: 4-26-23
Checked By:
Date:

TOTAL ONSITE EXISTING TO BLM = $Q_5 = 4.73$ cfs

$Q_{100} = 14.59$ cfs

DETENTION REQUIREMENT:

REDUCE 5-YEAR BY 0.83 cfs

REDUCE 100-YEAR BY 7.58 cfs

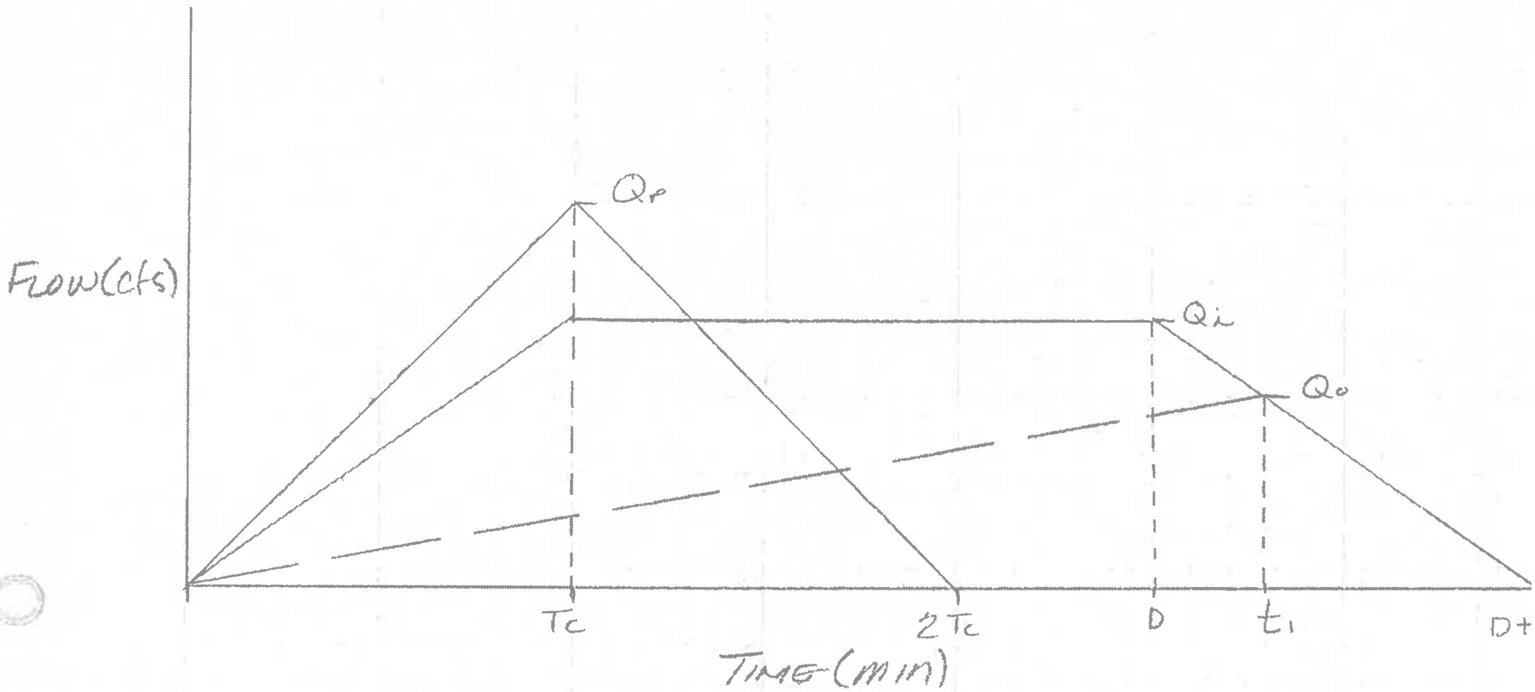
RUNOFF CAN BE CONTROLLED AT DETENTION POND

PROPOSED POND OUTFLOW:

$Q_5 = 4.23\text{ cfs} - 0.83\text{ cfs} = 3.40\text{ cfs}$

$Q_{100} = 19.90\text{ cfs} - 7.58\text{ cfs} = 12.32\text{ cfs}$

MODIFIED RATIONAL METHOD
EQUATIONS FOR ESTIMATING REQUIRED STORAGE
"I" METHOD



T_c = CONCENTRATION TIME (min)
D = RAINFALL DURATION (min)
Q_P = PEAK RUNOFF AT $D = T_c$ (cfs)
Q_i = PEAK RUNOFF AT D (cfs)
Q_o = ALLOWABLE POND OUTFLOW RATE (cfs)

$$t_1 = \left(\frac{Q_i - Q_o}{Q_i}\right)(T_c) + D$$

V_i = INFLOW VOLUME (cf)
V_o = OUTFLOW VOLUME (cf)
S = STORAGE (cf) $= V_i - V_o$

OJECT	PRO. #
SUBJECT	DATE 12-13-16
BY	SHEET 1 OF 2

$$\forall_i = \left[2(\tfrac{1}{2})(T_c)(Q_i)(60\ ^{s}/_{min})\right] + \left[(Q_i)(D-T_c)(60\ ^{s}/_{min})\right]$$

$$\forall_i = (Q_i)(D)(60\ ^{s}/_{min})$$

$$\forall_o = \left[\tfrac{1}{2}(t_1)(Q_o)(60\ ^{s}/_{min})\right] + \left[\tfrac{1}{2}(D+T_c-t_1)(Q_o)(60\ ^{s}/_{min})\right]$$

$$\forall_o = (Q_o)(D+T_c)(30\ ^{s}/_{min})$$

$$S = \left[(Q_i)(D)(60\ ^{s}/_{min})\right] - \left[(Q_o)(D+T_c)(30\ ^{s}/_{min})\right]$$

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Client: BOULDER CREEK Sheet ~~21~~ of ~~22~~
Description: OPHIR HILL HYDROLOGY
Job No. 9103.003
By: ECT Date: 4-28-23
Checked By: Date:

ROUGH ESTIMATE OF DETENTION STORAGE USING MODIFIED RATIONAL "I" METHOD

$$S = [(Q_i)(D)(60\,\text{MIN})] - [(Q_o)(D + T_c)(30\,\text{SEC/MIN})]$$

WHERE S = STORAGE (FT^3)
Q_i = INFLOW (CFS)
D = RAINFALL DURATION (MIN)
T_c = CONCENTRATION TIME (MIN)

FOR POND INFLOW: $A = 9.44\,ac$
$C_5 = 0.29$ $i_5 = 1.54\ \text{in/hr}$
$C_{100} = 0.55$ $i_{100} = 3.67\ \text{in/hr}$
$T_c = 11.70\ min$

ASSUME: FOR PRELIMINARY HYDROLOGY, SIZE POND FOR 100-YEAR RUNOFF

$$Q = CiA$$

FROM PAGE 18, $Q_o = 12.32\,cfs$

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Client: BOULDER CREEK Sheet ~~22~~ of ~~22~~
Description: OPHIR HILL HYDROLOGY
Job No. 9103.003
By:
Date: 4-28-23
Checked By:
Date:

D (MIN)	i (IN/HR)	Qi (cfs)	REQUIRED STORAGE (FT³)
Tc = 11.70	3.67	19.19	4822.7
15	3.28	17.03	5458.5
20	2.92	15.16	6476.4
25	2.57	13.34	6450.8
21	2.85	14.81	6571.6
22	2.78	14.44	6601.6
23	2.71	14.07	6587.1
22.50	2.75	14.25	6599.9
22.10	2.77	14.40	6602.2
22.20	2.77	14.36	6602.27
22.3	2.76	14.33	6601.94
22.25	2.76	14.34	6602.16
22.21	2.77	14.35	6602.26
22.15	2.77	14.38	6602.27
22.16	2.77	14.38	6602.28
22.17	2.77	14.37	6602.29
22.18	2.77	14.37	6602.29

REQUIRED STORAGE VOLUME ≈ 6602 FT³

APPROX POND VOLUME

ELEV	AREA	ΔV	ΣV
77.0	0	0	0
78.0	5018	2509	2509
79.0	6182	5600	8109
80.0	>7264	6723	14832

AVAILABLE POND STORAGE VOLUME = 14832 FT³ OK

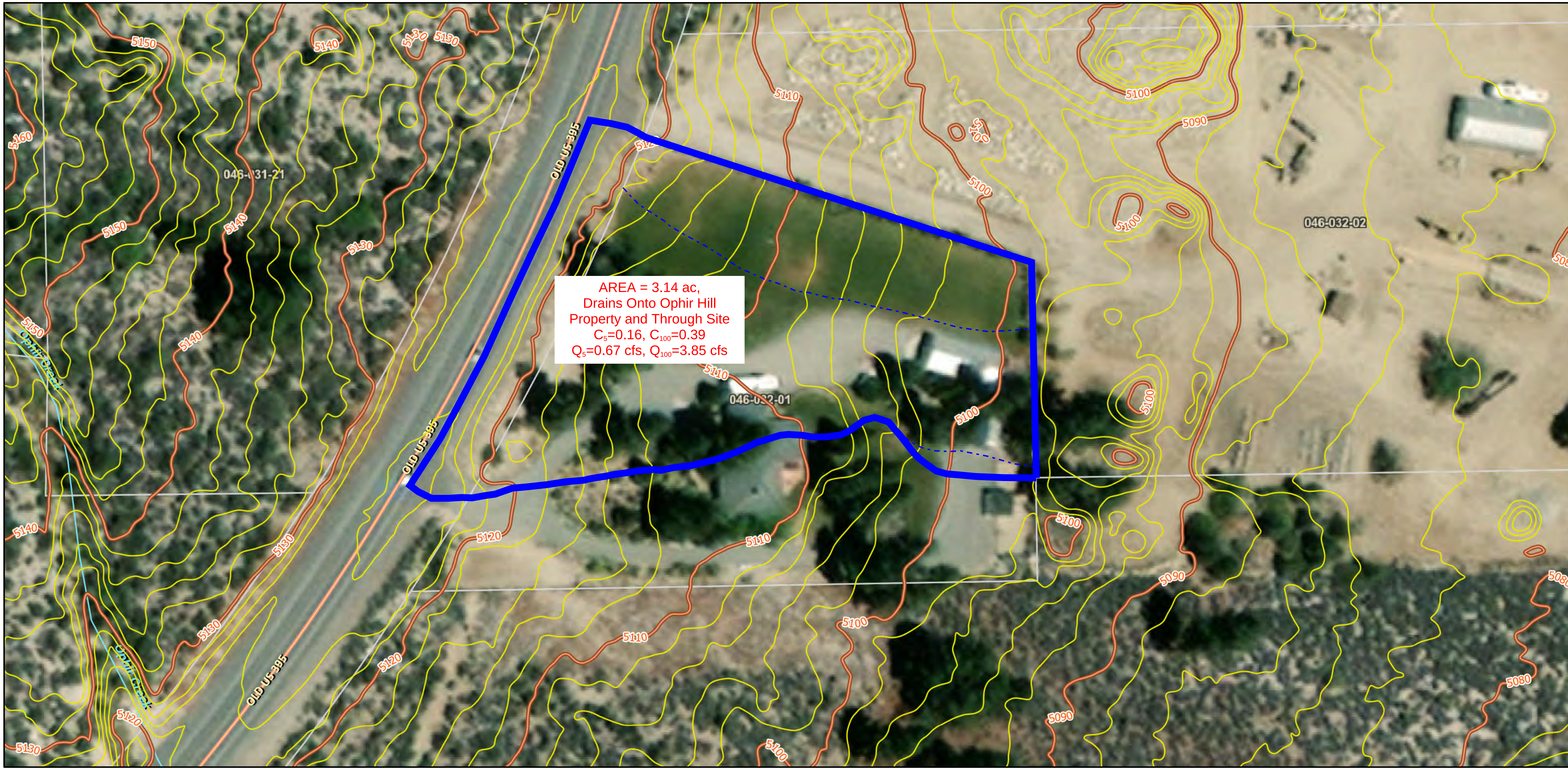
APPENDIX C

- DRAINAGE EXHIBITS


Ophir Hill Offsite
C5 = 0.20
C100 = 0.50
5-year intensity = 0.94 in/hr
100-year intensity = 2.31 in/hr
Legend
Ophir Hill Catchment
Ophir Hill Rd
Davis Creek
48.6 Ac
36" Culvert
Q5 = 9.18 cfs
Q100 = 56.19 cfs
Ophir Creek
Ophir Hill Rd
N
2000 ft
Google Earth

3280 Old US 395

DRAINGE AREA



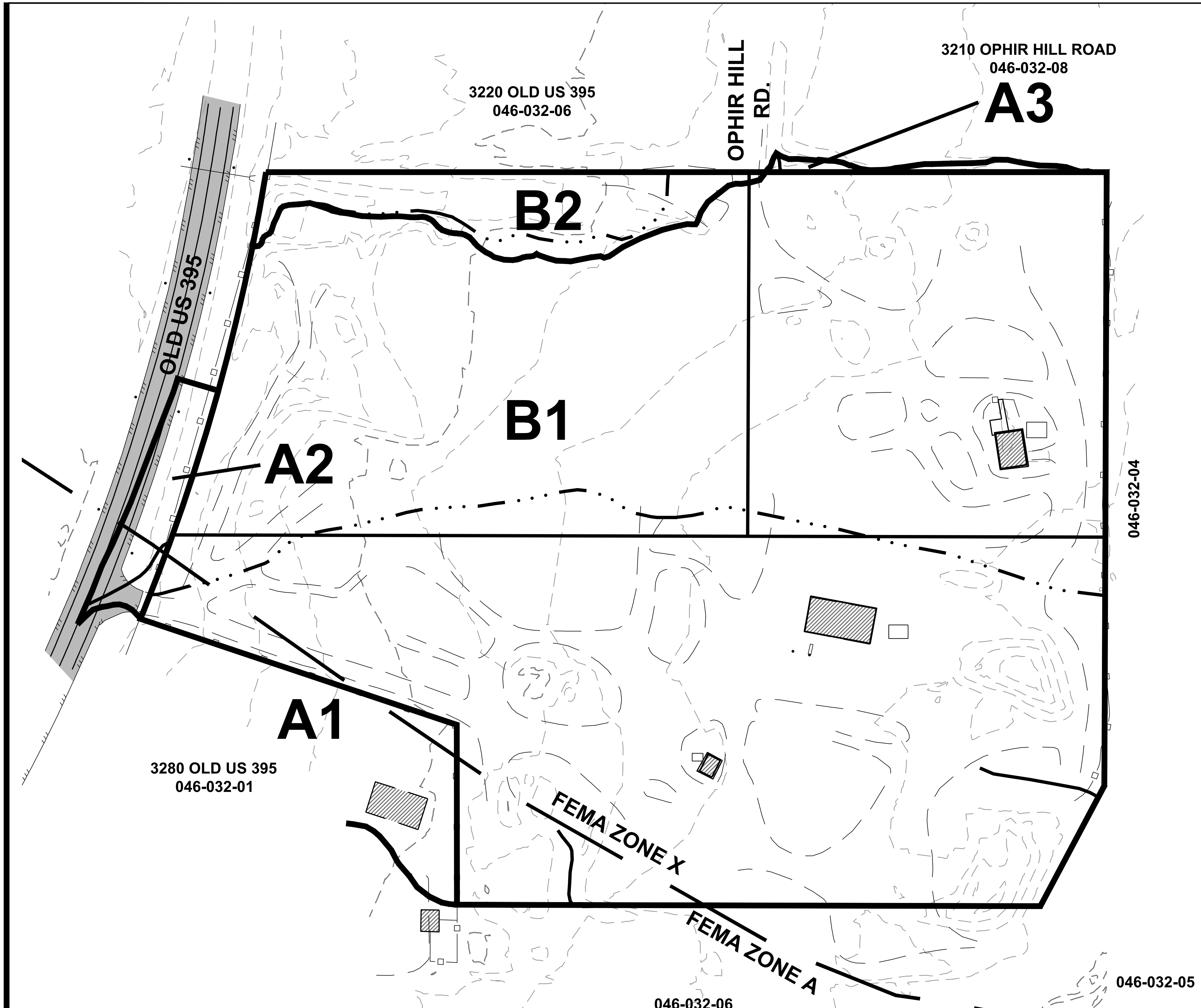
June 6, 2022

1:1,128

0 70 140 280 ft

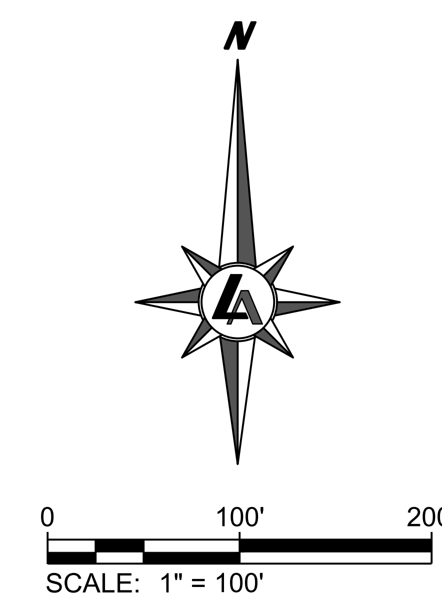
0 20 40 80 m

Washoe County
Washoe County GIS
Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community



PRE-DEVELOPMENT DRAINAGE AREAS

BASIN	AREA (AC)	C_5	C_{100}	Tc (MIN)	i_5 (IN/HR)	i_{100} (IN/HR)	Q_5 (CFS)	Q_{100} (CFS)
A1	3.13	0.13	0.37	21.06	1.17	2.81	0.48	3.25
A2	0.23	0.44	0.65	10.00	1.66	3.97	0.12	0.17
A3	0.05	0.20	0.50	10.00	1.66	3.97	0.02	0.10
B1	10.76	0.35	0.45	20.26	1.19	2.87	4.53	13.98
B2	0.53	0.35	0.45	10.00	1.66	3.97	0.31	0.95



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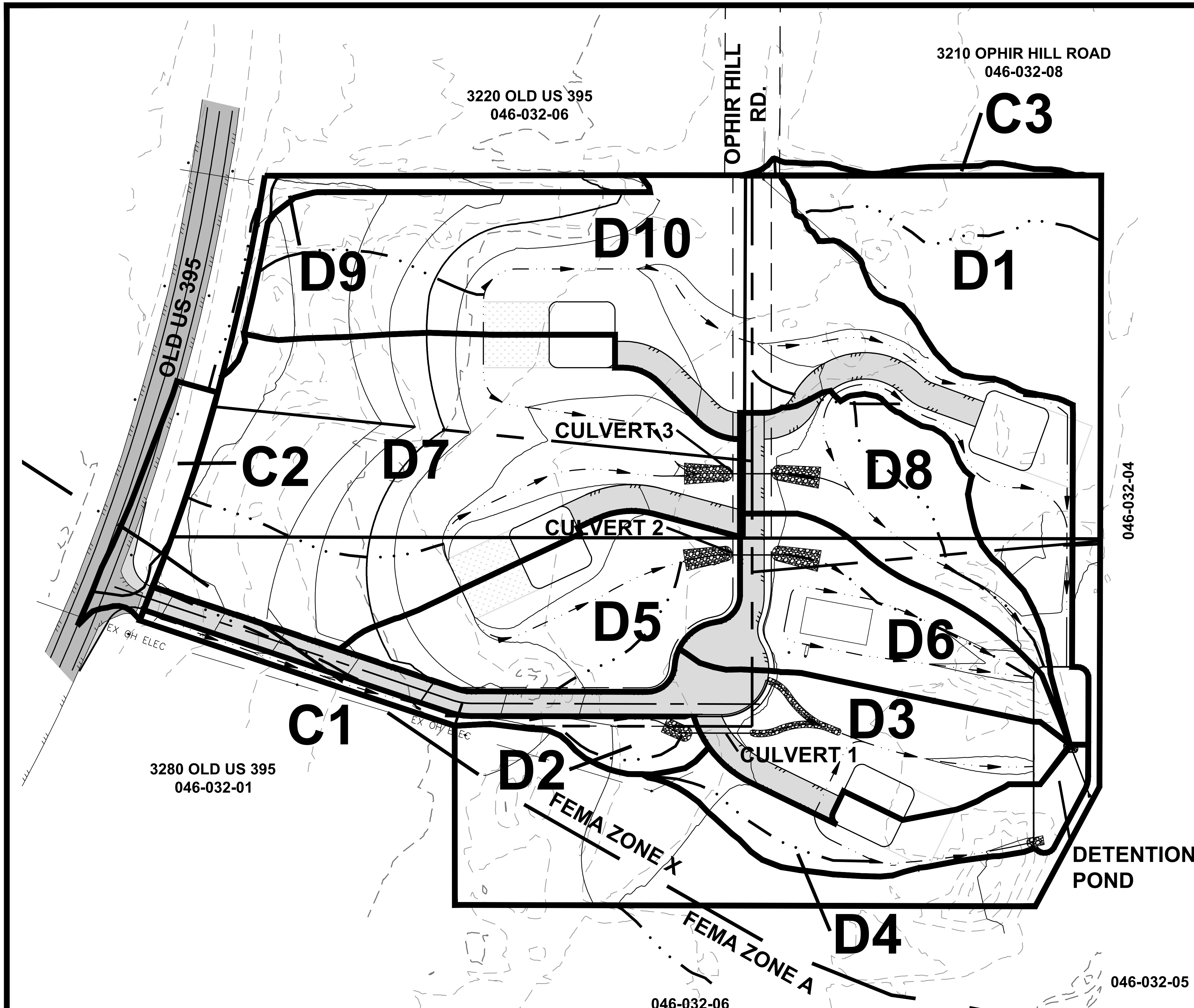
BOULDER CREEK ENTERPRISES

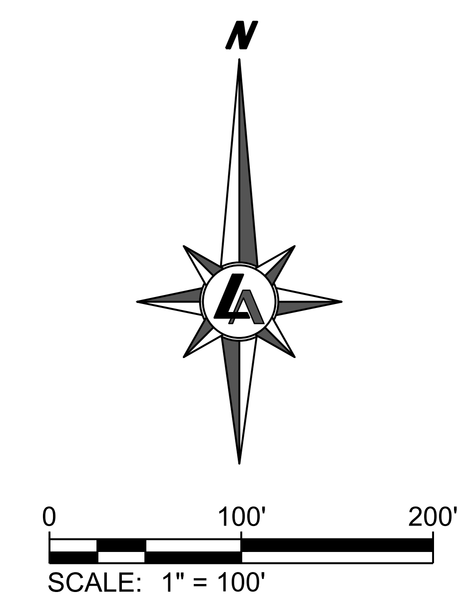
PRELIMINARY HYDROLOGY
PRE-DEVELOPMENT CONDITION AND DRAINAGE AREAS

WASHOE COUNTY NEVADA

Date: MAY, 2023
Scale: 1"=100'
Job No: 9103.003
FIGURE H-1



PROPOSED DRAINAGE AREAS								
BASIN	AREA (AC)	C_5	C_{100}	Tc (MIN)	i_5 (IN/HR)	i_{100} (IN/HR)	Q_5 (CFS)	Q_{100} (CFS)
C1	3.14	0.16	0.39	16.94	1.30	3.13	0.67	3.85
C2	0.23	0.50	0.69	10.00	1.66	3.97	0.19	0.63
C3	0.04	0.20	0.50	10.00	1.66	3.97	0.01	0.08
D1	2.14	0.20	0.05	17.18	1.29	3.11	0.55	3.32
D2	0.22	0.20	0.50	10.00	1.66	3.97	0.07	0.44
D3	1.23	0.45	0.66	10.00	1.66	3.97	0.92	3.21
D4	0.49	0.24	0.51	18.10	1.26	3.03	0.15	0.76
D5	0.86	0.22	0.51	11.17	1.57	3.76	0.30	1.64
D6	0.75	0.34	0.59	5.00	2.17	5.22	0.56	2.30
D7	2.36	0.24	0.52	12.89	1.47	3.50	0.84	4.32
D8	0.71	0.27	0.54	11.70	1.54	3.67	0.29	1.41
D9	0.03	0.20	0.50	10.00	1.66	3.97	0.01	0.06
D10	2.59	0.27	0.54	15.76	1.34	3.22	0.95	4.52



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BOULDER CREEK ENTERPRISES

PRELIMINARY HYDROLOGY
PROPOSED CONDITION AND DRAINAGE AREAS

WASHOE COUNTY NEVADA

Date: MAY, 2023
Scale: 1"=100'
Job No: 9103.003
FIGURE H-2

GEOTECHNICAL INVESTIGATION REPORT

OPHIR HILL GRADING SUP

JN: 9103.002

NEW WASHOE CITY, NEVADA

MAY 2022

PREPARED FOR:
BURDICK EXCAVATING
5 BROWN DRIVE
MOUND HOUSE, NV 89706

PREPARED BY:
LUMOS & ASSOCIATES, INC.
808 E. COLLEGE PARKWAY, SUITE 101
CARSON CITY, NEVADA 89706
775.883.7077

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3.0 Seismic Consideration **4**
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Appendix C – Design Response Spectrum
Appendix D – Pavement Design

1.0 INTRODUCTION

Submitted herewith are the results of Lumos and Associates, Inc. (Lumos) geotechnical investigation for the proposed residential Development to be located on parcels 046-032-02, -04 and, -05 in New Washoe City, Nevada. The properties are currently being utilized for the manufacture and excavation of landscape boulders and sand materials used in construction and landscaping. The properties are bounded by Old US 395 to the West and both privately and publicly owned parcels to the North, South, and East. A vicinity map is included as Plate 1 and a site map is included as Plate 2.

We understand improvements on the 11.29-acre site will consist of four (4) residential structures with conventional spread footings and concrete slabs-on-grade, with asphalt pavement and associated concrete hardscapes. The anticipated loads for the project have been assumed to be less than four (4) to five (5) kips/linear foot for continuous footings and sixty (60) to sixty-five (65) kips for isolated interior footings. We have assumed that the final grades will be within ten (10) feet of existing grades.

The purpose of our investigation was to characterize the site geology and soil conditions, describe the native soils, and determine their engineering properties as they relate to the proposed construction. The investigation was also intended to identify possible adverse geologic, soil, and or water table conditions. However, this study did not include an environmental assessment, a fault study, a liquefaction study or an evaluation for soil and/or groundwater contamination at the site.

This report concludes with recommendations for site grading, foundations, footing area preparation, utility installation, asphalt concrete pavement, and Portland cement concrete.

In addition, information such as logs of all test pits, allowable soil bearing capacities, estimated total and differential settlements, moisture and drainage protection and International Building Code (IBC) seismic site class designation are provided in this report.

The recommendations contained herein have been prepared based on our understanding and assumptions of the proposed construction, as outlined above. Re-evaluation of the recommendations presented in this report should be conducted after the final site grading and construction plans are completed, if there are any variations from the assumptions described herein.

It is possible that subsurface discontinuities may exist between and beyond exploration points. Such discontinuities are beyond the evaluation of the Engineer at this time. No guarantee of the consistency of site geology and sub-surface conditions is implied or intended.

2.0 GEOLOGIC SETTING

New Washoe city is located at the western portion of the Great Basin geomorphic province. The Great Basin is characterized by large normal fault-bounded valleys (grabens) that are separated by large mountain ranges (horst). The Sierra Nevada province to the west is characterized by large granite masses that have been uplifted and tilted a few degrees toward the west. Overlying the granites are older oceanic meta-sedimentary rocks. The geologic evolution of the region involves uplift, volcanism, extension, and sedimentation. All these factors have contributed to the current "Basin and Range" physiography.

Specifically the project site is located in a region historically known for landslides. The South East face of Slide Mountain, located approximately three miles from the site, periodically shears away from the greater mountain sending millions of cubic yards of granite rock and decomposed granite down Ophir Creek. Through geologic surveys, multiple landslides from Slide Mountain have been identified and dated at occurring all the way back to the Pleistocene era (2.6 million to 11,700 years ago). The most recent large scale landslide event took place in 1983, where an estimated 1.4 million cubic yards of material sweep into the Washoe Valley. In 2019 C. Carlson, R. Koehlera, and C. Henry mapped the geologic conditions surrounding Washoe City. Their investigation determined soils conditions beneath the site to be younger alluvial fan deposits and historical debris flow deposits.

Image 1: Slide Mountain

3.0 SEISMIC CONSIDERATIONS

New Washoe City, similar to many areas in Nevada, is located near active faults that are capable of producing significant earthquakes. We reviewed the Quaternary Fault Map of Nevada's interactive map (https://www.arcgis.com/apps/webappviewer/index.html) which shows the nearest active fault of Holocene age (<15,000 years), the Mount Rose Fault Zone, to be two-thousand (2000) feet to the West of the site. No Holocene faults extend into the site and no evidence of faulting was noted during our site investigation. Refer to Plate 4. The maximum credible earthquake (MCE) for the vicinity of the project is estimated at 7.5 in moment magnitude and many large earthquakes have occurred near the site as presented on Plate 5. This correlates to a Modified Mercalli Intensity of IX-X. Refer to Plate 6.

Liquefaction is the phenomenon where loose saturated granular soils lose their shear strength when subjected to strong vibration or cyclical loading and become unstable. Large earthquakes, as described above, may provide that type of cyclical loading. Loose saturated sands are the most susceptible to this phenomena. These conditions were not encountered during our field investigation. The soils encountered on-site were primarily slightly moist to moist, loose to medium dense sands with a varying matrix of silts, gravel, cobbles, and boulders. Therefore, the liquefaction of subsurface soils at the site is not considered likely to occur. The majority of any structural damage to buildings at this site is most likely to be the result of strong seismic shaking rather than subsurface soil liquefaction.

2018 IBC Design: The mapped maximum considered earthquake spectral response acceleration at short periods (S_S) is 2.15g corresponding to a 0.2 second spectral response acceleration at five percent (5%) of critical damping and for a Site Class B (IBC Figure 1613.2.1(1)). The mapped maximum considered earthquake spectral response acceleration at a 1-second period (S_1) is 0.764g corresponding to a 1.0 second spectral response acceleration at five percent (5%) of critical damping and for a Site Class B (IBC Figure 1613.2.1(2)). At this time, the soil conditions are not known in sufficient detail to a depth of 100 feet, thus, a Site Class D-default may be assumed per the IBC. These spectral response accelerations are adjusted for site class effects because Site Class D-default is assumed instead of Site Class B. The site coefficient for spectral response accelerations adjustment at short periods (F_a) is 1.2 (IBC Table 1613.2.3(1) and Section 1613.2.2). The maximum considered earthquake spectral response acceleration parameter for short period (S_{MS}) is 2.58g. This corresponds to design spectral response acceleration parameters of 1.72g for short period (S_{DS}). Refer to Appendix C.

It is emphasized that the above values are the minimum requirements intended to maintain public safety during strong ground shaking. These minimum requirements are meant to safeguard against loss of life and major structural failures, but are not intended to prevent damage or insure the functionality of the structure during and/or after a large seismic event.

The seismic risks at this site are similar to other sites within western Nevada. The risks associated with this site can be mitigated utilizing widely accepted design and construction standards.

4.0 SITE CONDITIONS AND FIELD EXPLORATION

At the time of our investigation, the site had been partially developed with utilities and non-permanent structures. The site slopes downwards towards Washoe Lake at approximately a 4.8% slope. Vegetation consists of sparsely located trees around the perimeter of the property.

The current field investigation included a site reconnaissance and subsurface exploration. During the site reconnaissance, surface conditions were noted, and the location of the exploratory test pits were determined by utilizing existing features on the site. Therefore, the approximate location of the test pits should be considered accurate only to the degree implied by the methods used.

Seven (7) test pits were excavated within the proposed improvement areas to a maximum depth of fifteen (15) feet below-ground-surface (bgs). The locations of the exploratory test pits within the site are shown on Plate 2. The subsurface soils were continuously logged and visually classified in the field by our Geotechnician in accordance with the Unified Soil Classification System (USCS). Along with classification of the subsurface soils, the current depth of debris flow material was identified and logged. Debris flow material depths were identified through the visual observation of the trench wall lithology during excavation and the presence of organic or otherwise non-native materials present in the trench spoils. Table 1 shows the identified depth of debris flow material determined in each test pit.

Image 2: Clear Delineation Between Debris Flow Material

TABLE 1
EXISTING DEPTH OF DEBRIS FLOW MATERIAL

Exploration	Depth of Debris Flow Material
TP-1	8 Feet
TP-2	7 Feet
TP-3	No Certain Depth Identified
TP-4	8 Feet
TP-5	4 Feet
TP-6	6 Feet
TP-7	8 Feet

The subsurface soils encountered consisted generally of poorly graded to well graded sands (SP or SW) with varying amounts of silt, silty sands (SM), and poorly-graded sands (SP) to the total depths explored for this project. The debris flow material was clearly identified in all test pits except for test pit 3. The debris flow material contained varying amounts of cobbles and boulders with the maximum particle size encountered being approximately four (4) feet in diameter. Uncontrolled fill, containing debris, was encountered in test pit 3 to approximately four (4) feet below existing ground surface. Uncontrolled fill and disturbed soils are not suitable to provide direct structural support due to their settlement potential. Groundwater was not encountered at the time of our investigation and is not expected to impact the development of this site. However, seasonal groundwater fluctuations should be anticipated at the site.

5.0 FIELD AND LABORATORY TEST DATA

Field data was developed from samples taken and tests conducted during the field exploration and laboratory testing phases of this project. The test pits were excavated using a Caterpillar 330 DL excavator and samples of each material encountered were collected using bulk sampling techniques. All the samples were subsequently transported to our Carson City geotechnical laboratory for testing and analysis.

Laboratory tests performed on representative samples included sieve analysis (included fines), Atterberg limits, modified proctor, resistance value, direct shear, soluble sulfates, pH value, resistivity, and solubility. Much of this data is displayed on the "logs" of the exploratory test pits to facilitate correlation. Field descriptions presented on the logs have been modified, where appropriate, to reflect laboratory test results. The logs of the exploratory test pits are included in Appendix A of this report as Plates A-1 to A-7. A key to the logs is included as Plate A-8.

Individual laboratory test results are presented in Appendix B as Plates B-1 through B-6. Laboratory testing was performed per ASTM standards, except when test procedures are briefly described and no ASTM standard is specifically referenced in the report. Atterberg limits were determined using the dry method of preparation.

Analytical Testing: Silver State Laboratory, Inc. of Reno, Nevada, conducted this laboratory testing. Testing results are included (Silver State's letterhead) as Plate B-6.

The soil samples obtained during this investigation will be held in our laboratory for 30 days from the date of this report. The samples may be retained longer at an additional cost to the client or obtained from this office upon request.

6.0 DISCUSSION AND RECOMMENDATIONS

6.1 General

From a geotechnical viewpoint, the site is considered suitable for the proposed development when recommended herein.

The following recommendations are based upon the construction and our understanding and assumptions of the proposed improvements, as outlined in the introduction of this report, and based on our findings during the field exploration phase of this project. If changes in the construction project are proposed, they should be presented to Lumos & Associates, Inc., so that the recommendations provided herein can be reviewed and modified as necessary. As a minimum, final construction drawings should be submitted to Lumos for review prior to actual construction and verification that our Geotechnical design recommendations have been implemented

6.2 General Site Grading

6.2.1 Clearing and Grubbing

Prior to placement of fill and/or the proposed improvements, the areas to receive fill and/or improvements shall be cleared and grubbed. Clearing and grubbing should be anticipated to be as much as eight (8) inches.

Root- or organic-laden soils encountered during excavations, should be stockpiled in a designated area on site for later use in landscaping, or removed off site as directed by the owner. Excavated soils free from any organics, debris or otherwise unsuitable material and with particles no larger than four (4) inches in maximum dimension may be stockpiled and moisture conditioned for later use as compacted fill provided it meets the criteria for structural fill soils.

Exposed excavation surfaces to support any of the proposed improvements should be observed and approved by a Lumos representative. Upon re-compaction and prior to placing any base, the re-compacted surface should be proof-rolled to identify any possible yielding surfaces. Proof-rolling should be conducted with a heavy rubber-tire loader with a fully loaded bucket, or a fully loaded water truck, and observed and approved by a Lumos representative.

6.2.2 Unsuitable Subgrade Mitigation

Unstable conditions due to yielding and/or pumping soils may be encountered on site. Additionally, the exposed soils may yield or pump under heavy equipment loads or where vibratory equipment draws up water. If yielding or pumping conditions are encountered, the soils should be scarified in place, allowed to dry as necessary and re-compacted, where applicable. Alternatively, unsuitable or saturated soil should be removed, the exposed surface leveled and compacted/tamped as much as practical without causing further pumping, and covered (including the sides) with geotextile stabilizing fabric (Mirafi HP370 or other equivalent). The fabric should then be covered with at least 12 inches of 4 to 8 inch **angular rock fill** with enough fines to fill the inter-rock pore spaces. Placement should be by end dumping. No traffic or other action should be allowed over the fabric, which may cause it to deflect/deform prior to cobble placement. Test sections should be used to determine the minimum thickness and/or number of layers required for stabilization.

Stabilization should be evaluated by proof-rolling standards commensurate with the equipment used, and approved by a Lumos representative. The placement of the stabilizing rock-fill may require additional over-excavation to maintain appropriate grading elevations. A filter fabric (Mirafi 180N or equal) should also be placed over the cobble rock fill to prevent piping of fines from covering soils into the stabilizing rock matrix.

The uncontrolled fill (Poorly Graded Sand with Silt Chunks (SM)), as encountered in the upper four (4) feet of test pit 3, shall be completely removed, when encountered, from below the structures and improvements and to a distance of two (2) feet beyond improvements/foundations horizontally. Once excavated the material may be screened to completely remove debris. This "screened" material may be utilized as structural fill/trench backfill provided it meets the criteria stated in the following section (6.2.3). The exposed surface shall be scarified to a depth of twelve (12) inches, moisture conditioned to within two percent (2%) of optimum and compacted to at least ninety-five percent (95%) relative compaction as determined by the ASTM D 1557 Standard.

The landslide material (Poorly Graded Sands with Silt (SP-SM), Well Graded Sands with Silt (SW-SM) and, Silty Sand (SM)) as encountered in the upper four (4) to eight (8) feet of test pits 1, 2, 4, 5, 6, and 7, which are anticipated throughout the entire site, require mitigation due to the relatively low in-place density tests and large quantity of boulders encountered during our field investigation. Our recommended mitigation is to remove the upper three (3) feet of these soils from below future foundations and slabs and two (2) feet below future roadways. The removal shall extend a minimum of two (2) feet beyond the proposed improvements/foundations. These soils may be reutilized as structural fill provided the particles larger than four (4) inches are removed and they meet the criteria stated in the following section (6.2.3). The exposed surface shall be scarified to a depth of twelve (12) inches, moisture conditioned to within two percent (2%) of optimum and compacted to at least ninety-five percent (95%) relative compaction as determined by the ASTM D 1557 Standard.

6.2.3 Structural Fill and Trench Backfill

Properly compacted structural fill and trench backfill soils to be used on site should consist of non-expansive materials [LL less than thirty-five (35) and/or a PI less than twelve (12) and/or Expansion Index less than twenty (20)], should be free of contaminants, organics [less than two (2) percent], rubble, or natural rock larger than four (4) inches in largest dimension and have a minimum R-Value of thirty (45). All structural fill and trench backfill soils shall also be non-corrosive and have a water soluble sulfate content of less than one-tenth (0.1) percent. Structural fill and trench backfill soils shall also meet the following gradation requirements:

TABLE 2
STRUCTURAL FILL/TRENCH BACKFILL GRADATION

Sieve Size	% Passing
4"	100
¾"	70 - 100
#40	15 - 65
#200	5 - 25

Structural fill and trench backfill soils that do not meet the above requirements may be approved at the discretion of the Geotechnical Engineer. The site soils (SP-SM, SW-SM, and SM) encountered during the exploration are suitable for reuse as structural fill/trench backfill provided the particles larger than four (4) inches are removed and the recommendations that follow in this section are adhered to.

Prior to placement of structural fill, the site subgrade shall be scarified to a depth of twelve (12) inches, oversized material removed (+4"), moisture conditioned to within two percent (2%) of optimum, and recompacted to a minimum of ninety-five percent (95%) as determined by the ASTM D1557 Standard.

Structural fill and trench backfill should be placed only on compacted sub-grade or on compacted fill in loose lifts not exceeding twelve (12) inches, moisture conditioned to within two percent (2%) of optimum and compacted to at least ninety-five percent (95%) relative compaction as determined by the ASTM D1557 Standard.

Fill material should not be placed, spread or compacted while the ground is frozen or during unfavorable weather conditions. When site grading is interrupted by heavy rain or snow, grading or filling operations should not resume until a Lumos representative approves the moisture content and density conditions of the subgrade or previously placed fill. When fill is placed on existing slopes steeper than 5:1, the existing slope shall be horizontally benched.

Landscape areas should be cleared of all objectionable material. In cut areas, no other work is necessary except grading to proper elevation. In landscape areas, fill should be placed in loose lifts not exceeding eight inches and compacted to at least ninety percent (90%) relative compaction to prevent erosion.

Water should not be allowed to pond on pavements or adjacent to structures, and measures should be taken to reduce surface water infiltration into the subgrade soils. A representative of Lumos should be present during site grading operations to ensure any unforeseen or concealed conditions within the site are identified and properly mitigated, and to test and observe earthwork construction. This testing and observation is an integral part of our service as acceptance of earthwork construction is dependent upon compaction and stability of the subgrade soils. The soils engineer may reject any material that does not meet engineering characteristics, compaction, and stability requirements. Further, recommendations of this report are based upon the assumption that earthwork construction will conform to recommendations set forth in this section of the report.

6.3 Debris Flow Protection and Remediation

Due to the site's location directly in-line with the outflow of Ophir Creek results in the site requiring protection from possible debris flows generated from Slide Mountain. A number of debris flows have been identified to have crossed through the site. An engineered system should be developed in order to protect from the loss of life and property during a debris flow event. There are many accepted landslide protection systems including: gravity retaining walls, crib-block walls and, reinforced concrete walls. Due to the potential risk associated with the site's location we recommend a landslide hazard investigation and assessment in order to appropriately design a protective system.

7.0 FOUNDATION DESIGN CRITERIA

Conventional spread footings founded on properly prepared structural fill, as discussed earlier in the report, may be used to support the proposed buildings within the project site.

Spread footings: Footings should have a minimum embedment of twenty-four (24) inches below lowest adjacent grade for frost protection. Footings founded on properly prepared structural fill as discussed earlier in this report may be designed for a net allowable bearing pressure of 1,500 pounds-per-square-foot (psf). This relatively low bearing value allows for partial removal and recompaction of the debris flow material from beneath the foundations and roadway improvements, as previously discussed.

Footing Settlements: The maximum anticipated settlements, caused by static loading, for continuous or isolated footings bearing on properly prepared structural fill/suitable subgrade and designed for a 1,500 (psf) bearing pressure is estimated at one (1) inch or less. Differential settlements are generally expected to be half of the total settlements. Settlements in granular soils are primarily expected to occur shortly after dead and sustained live loads are applied.

Lateral Loading: Resistance to lateral loads can be provided by friction acting at the base of foundations and by lateral earth resistance. A coefficient of friction of 0.45 may be assumed at the base of footings supported by properly compacted structural fill. An allowable passive earth resistance of 250 psf per foot of depth starting six (6) inches below lowest adjacent grade may be used for the sides of footings poured against properly compacted structural fill. Passive resistance should not exceed 1,500 psf. The at-rest lateral pressure can be calculated utilizing an equivalent fluid pressure of 65 pcf.

Dynamic Factors: Vertical and lateral bearing values indicated above are for total dead-load and frequently applied live loads. If normal code requirements are applied for design, the above vertical bearing values may be increased by thirty-three percent (33%) for short duration loading due to wind or seismic forces. The additional Dynamic Lateral earth pressure can be calculated utilizing the following equation.

Dynamic Lateral Force (Non-Yielding Walls) =

$\gamma K_h H^2 = 90H^2$

Dynamic Lateral Force (Yielding Walls) =

$3/8\gamma K_h H^2 = 34H^2$

Horizontal Acceleration = K_h =

SDs/2.5 = 0.69

Unit Weight of Soil = γ = 130 pcf

Height of Wall = H

This force should be assumed to act at a height of 0.6H above the bottom of the wall.

8.0 CONCRETE SLAB DESIGN

Interior concrete slabs should be underlain with at least six (6) inches of Type 2, Class B, Aggregate Base, compacted to a minimum of ninety-five percent (95%) and supported on at least thirty-six (36) inches of properly prepared structural fill. A vapor barrier should be provided for all interior concrete slabs where floor moisture is undesirable. The vapor barrier should be a synthetic plastic sheeting at least ten (10) mils thick and meet the requirements of the ASTM E1745 for Class A vapor retarder materials. The vapor barrier shall be installed per the manufacturer's recommendations. We recommend utility trenching be completed prior to vapor barrier and base placement.

Slab thickness design should be based on a Modulus of Subgrade Reaction equal to two hundred (200) pounds-per-cubic-inch (pci) for construction on properly compacted aggregate base/structural fill. Reinforcement of concrete slabs should be as specified by the Project Structural Engineer.

Exterior concrete slabs on grade for vehicular traffic and driveways should be underlain with at least six (6) inches of Type 2, Class B aggregate base and twenty-four (24) inches of properly compacted structural fill. All subgrade and fill should be prepared and placed as described in the grading section of this report, while the aggregate base should be compacted to at least ninety-five percent (95%) relative compaction.

9.0 RETAINING WALLS

Retaining structures over three (3) feet in height, if used, will require local code compliance and engineered based on parameters described in this section of the report. Retaining structures should be designed to resist the appropriate lateral earth pressures. Cantilevered walls, which are able to deflect at least 0.01 radians, can be designed using an equivalent fluid (backfill) unit weight of 45 pounds-per-cubic-foot (pcf). However, if the wall is fixed against rotation, the wall should be designed using an equivalent fluid (backfill) unit weight of 65 pcf. These design parameters are based upon the assumption that walls will retain only level backfill and no hydrostatic pressure will be present. Any other surcharge pressures (such as sloped backfill) should be added to the above recommended lateral earth pressures. Retaining walls should be backfilled with free draining granular material that extends vertically to the bottom of the stem and laterally at least six (6) inches beyond the face of the stem (wall) and wrapped with a Mirafi 180 N or equivalent non-woven filter fabric. Weep holes should be provided on the walls at regular intervals, or a slotted drainpipe placed at the bottom of the wall (bottom of granular material) to relieve any possible build-up of hydrostatic pressure. Backfill material within two (2) feet of the wall should be compacted with hand-held equipment only, to at least ninety percent (90%) of the maximum ASTM D1557 standard. A brow ditch shall be constructed in the pre-retained earth parallel to the retaining wall to divert surface runoff.

10.0 PAVEMENT DESIGN

As previously discussed, the upper two (2) feet of soils shall be removed and recompacted. Prior to the placement and recompaction of the excavated material, the subgrade soils should be scarified in place to a depth of at least twelve (12) inches, moisture conditioned to within two percent (2%) of optimum, and compacted to at least ninety-five percent (95%) of the laboratory maximum dry density determined by the ASTM D1557 standard. Pavement structural sections utilizing an R-value of forty-five (45) for structural fill/backfill, and seventy (70) for aggregate base, are provided in Table 2, "Recommended Pavement Section". A Traffic Index (TI) value of 5.0, for light traffic areas was utilized in design. Aggregate base should consist of Type 2, Class B material and meet the requirements of the Standard Specifications for Public Works Construction (SPPWC). Aggregate base material should be compacted to at least ninety-five percent (95%) of the laboratory maximum density as determined by the ASTM D1557 standard.

TABLE 3
RECOMMENDED ASPHALT PAVEMENT SECTION

Assumed Traffic Index	Minimum Asphalt Pavement	Minimum Aggregate Base	Properly Prepared Suitable Subgrade/Structural Fill
Local Road TI = 5.0	3"	4"	24"

***See Appendix D for Calculations**.

In all areas of the project, asphalt concrete should consist of PG64-28NV, and Type 3 asphalt aggregate per the "Orange Book" standards. We recommend a 50-blow Marshall mix that targets three percent (3%) air voids. Asphalt concrete, in any case, should be compacted to between ninety-three percent (93%) and ninety-eight percent (98%) of the Rice theoretical maximum density.

All mix designs for asphalt concrete should be submitted to the Geotechnical Engineer for review and approval a minimum of seven (7) days prior to paving.

11.0 CORROSION AND CHEMICAL ATTACK

On-site soils have a negligible water soluble sulfate content of less than 0.1% (0.01%). However, Type II cement (meeting ASTM C150) is recommended for concrete in direct contact with on-site soils.

All exterior concrete should have between 4.5 and 7.5 percent entrained air, a maximum water-cement ratio of 0.45 and comply with all other ACI recommendations for concrete placed in areas subject to freezing. A minimum compressive strength of 4,000 psi is recommended for all external concrete. All interior concrete shall be placed pursuant to ACI recommendations.

Native soils have a pH of 5.64 and have a resistivity of 17,000 ohm-cm under saturated conditions. This indicates mildly corrosive potential for ferrous metals in contact with these soils. However, corrosion prevention measures are recommended. If protective coatings are used, the type and quantity will depend on the kind of steel and specific construction application. Steel and wire concrete reinforcement cover of at least three (3) inches where cast against soil, unformed, is recommended.

Solubility of native soils was measured at 0.3% which indicates that the site soils have a low solubility.

12.0 SLOPE STABILITY AND EROSION CONTROL

The results of our exploration and testing confirm that 3:1 (H:V) maximum slopes will be stable for on-site materials both in cut and fill. All slopes shall incorporate a brow ditch to direct surface drainage away from the slope face. Slopes steeper than 3:1 will require stabilization, such as retaining walls.

The potential for dust generation is high at this project. Dust control will be mandatory on this project in order to comply with air quality standards. The contractor shall be responsible for submitting a dust control plan and securing any required permits.

Stabilization of all slopes and areas disturbed by construction will be required to prevent erosion and to control dust. Stabilization may consist of rip-rap, revegetation, or dust palliative, depending on the inclination of the slope.

13.0 UTILITY EXCAVATIONS

On-site soils are anticipated to be excavatable with conventional construction equipment. Compliance with OSHA regulations should be enforced for Type C soils. The site soils encountered during the exploration are anticipated to be suitable for backfill of utility trenches, provided oversized (+4") material and debris is removed as discussed earlier in this report. Trench backfill/structural fill shall be moisture conditioned, placed and compacted as previously discussed in the grading and filling section. On-site soils encountered during our field exploration are not suitable for bedding sand (Class A Backfill). Therefore, import of Class A Bedding materials is warranted. Bedding sand shall be placed in eight (8) inch maximum loose lifts and compacted to a minimum of ninety percent (90%) of the ASTM D1557 Standard.

14.0 MOISTURE PROTECTION, EROSION AND DRAINAGE

The finish surfaces around all structures should slope away from the foundations and toward appropriate drop inlets or other surface drainage devices. It is recommended that within ten (10) feet of any structure a minimum slope of five percent (5%) be used for soil subgrade and a minimum of one percent (1%) be used for pavement. These grades should be maintained for the life of the structures.

15.0 CONSTRUCTION SPECIFICATIONS

All work shall be governed by the 2018 International Building Code and Standard Specifications and Standard Details for Public Works Construction (SSPWC) 2012/Revision 8, as distributed by Washoe County, except as modified herein.

16.0 LIMITATIONS

This report has been prepared in accordance with the currently accepted engineering practices in Northern Nevada and Northern California. The analysis and recommendations in this report are based upon exploration performed at the locations shown on the site plan, the proposed improvements as described in the Introduction section of this report and upon the property in its condition as of the date of this report. Lumos makes no guarantee as to the continuity of conditions as subsurface variations may occur between or beyond exploration points and over time. Any subsurface variations encountered during construction should be immediately reported to Lumos so that, if necessary, Lumos' recommendations may be modified.

This report has been prepared for and provided directly to Burdick Excavating ("The Client"), and any and all use of this report is expressly limited to the exclusive use of the Client. The Client is responsible for determining who, if anyone, shall be provided this report, including any designers and subcontractors whose work is related to this project. Should the Client decide to provide this report to any other individual or entity, Lumos shall not be held liable for any use by those individuals or entities to whom this report is provided. The Client agrees to indemnify, defend and hold harmless Lumos, its agents and employees from any claims resulting from unauthorized users.

If this report is utilized in the preparation of an Engineer's Estimate of Probable Construction Costs, then the preparer of the estimate acknowledges that the report recommendations are based on the subsurface conditions found at the specific locations investigated on site; that subsurface conditions may vary outside these locations; and that no guaranty or warranty, express or implied, is made that the conditions encountered are representative of the entire site. The preparer of the estimate agrees to indemnify, defend and hold harmless Lumos & Associates, its agents and employees from any and all claims, causes of action or liability arising from any claims resulting from the use of the report in the preparation of an Engineer's Cost Estimate.

This report is not intended for, nor should be utilized for, bidding purposes. If it is utilized for bidding purposes, Client acknowledges that the report recommendations are based on the subsurface conditions found at the specific locations investigated on site; that subsurface conditions may vary outside these locations; and that no guaranty or warranty, express or implied, is made that the conditions encountered are representative of the entire site. The Client agrees to indemnify, defend and hold harmless Lumos & Associates, Inc., its agents and employees from any and all claims, causes or action or liability arising from any claims resulting from the use of the report for bidding purposes.

As explained above, subsurface variations may exist and as such, beyond the express findings located in this report, no warranties express, or implied, are made by this report. No affirmation of fact, including but not limited to statements regarding suitability for use of performance shall be deemed to be a warranty or guaranty for any purpose.

PROFESSIONAL ENGINEER STATE OF NEVADA
MITCHELL T. BURNS
Exp: 12-31-22
CIVIL
No. 19901

5/23/22

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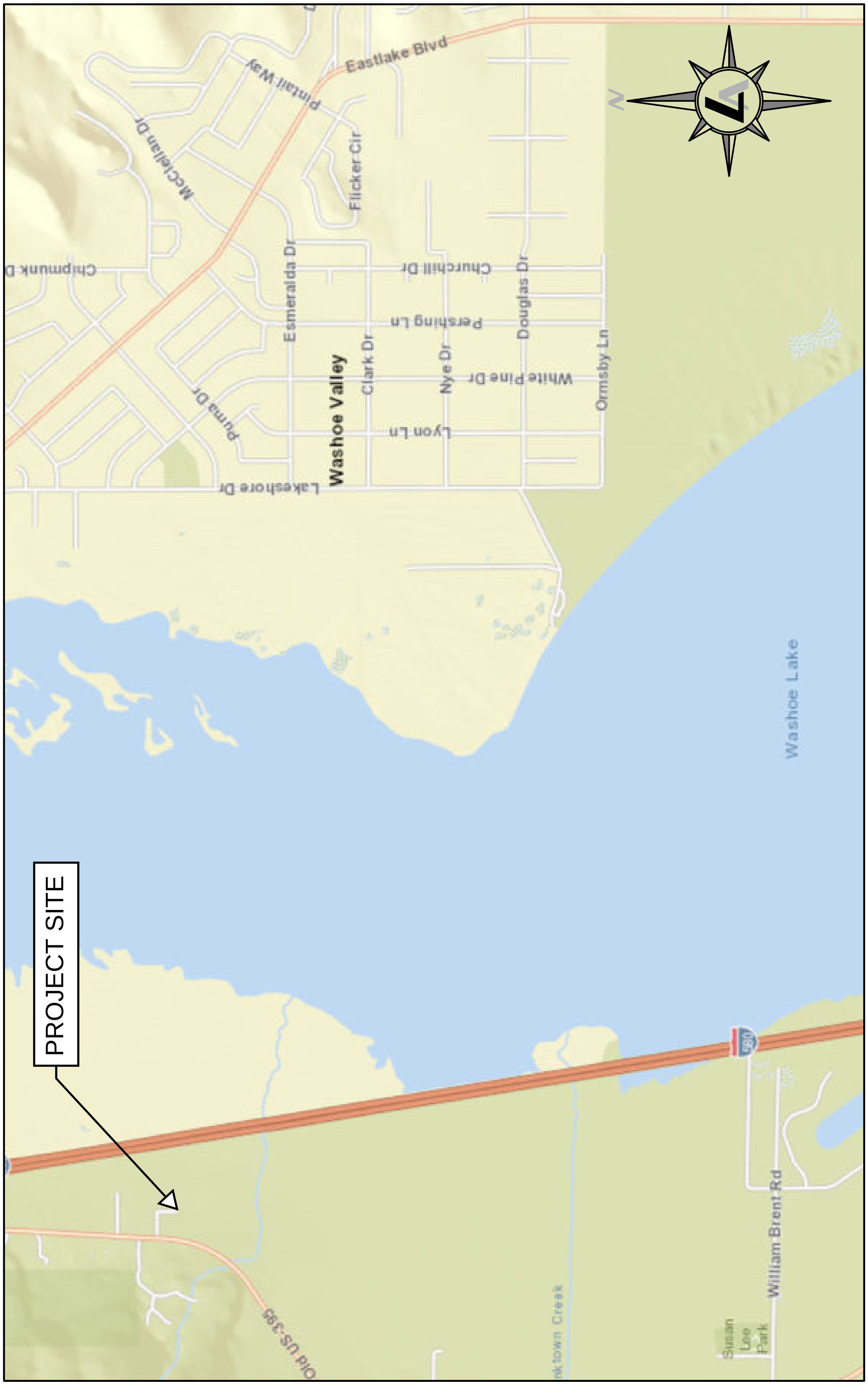

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0 0.23 0.45 0.9 mi

0 0.38 0.75 1.5 km

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand),

5/13/2022, 8:54:34 AM

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Ophir Hills Grading SUP

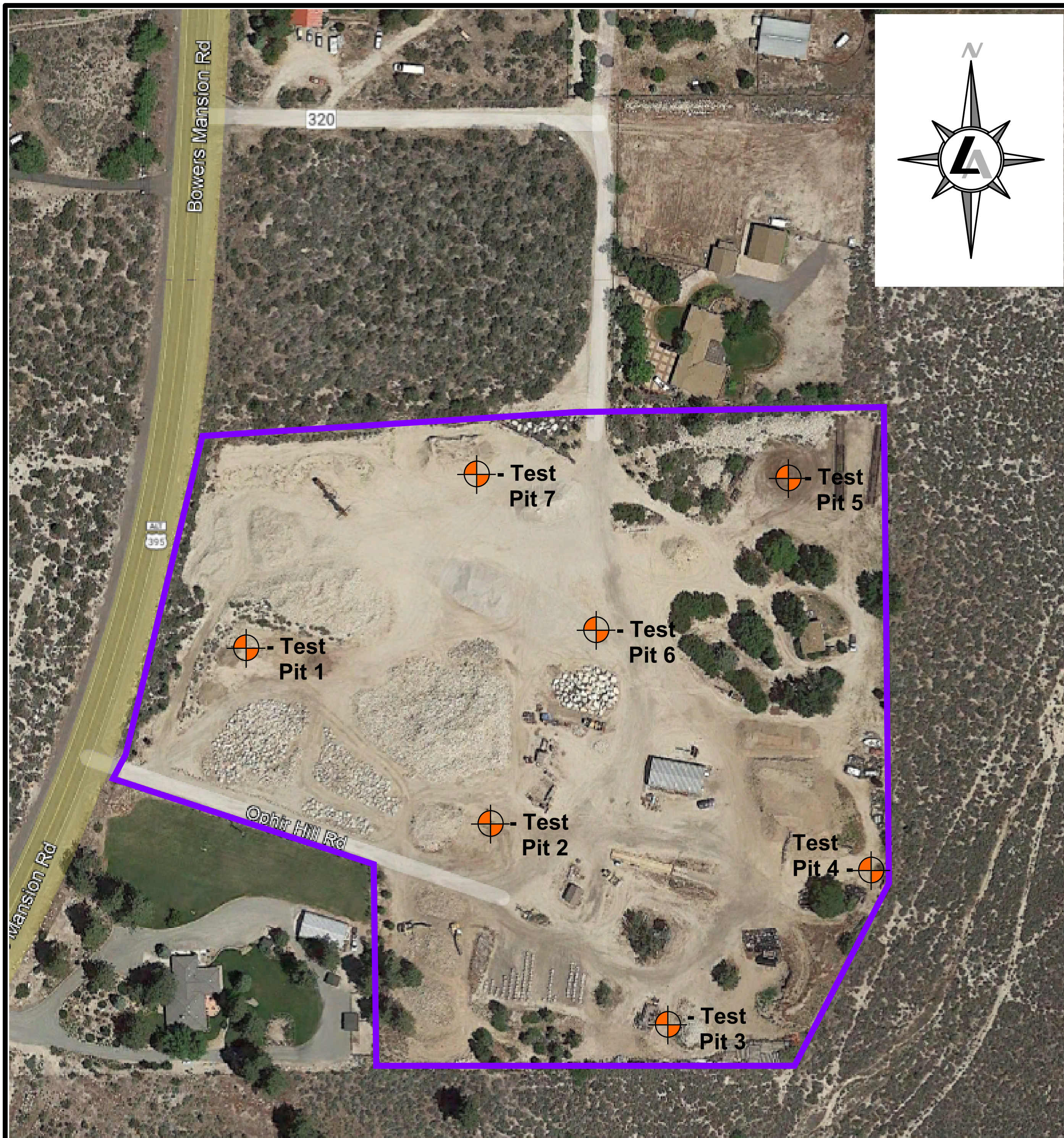
PROJECT VICINITY

Job Number: 9103.002

Date: May 2022

PLATE

1



Test Pit Location

Project Limits

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Ophir Hills Grading SUP

PROJECT SITE MAP

Job Number: 9103.002

Date: May 2022

PLATE

2

Qfy	**Young alluvial-fan deposits (late Holocene)**
Qdf_1	**Debris-flow deposits (historical)**

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PROJECT GEOLOGIC MAP

Job Number: 9103.002

Date: May 2022

PLATE

3

5/13/2022, 10:08:39 AM

Linear Faults

- Class B years
- Less than 1,600,000 years
- Less than 750,000 years
- Less than 130,000 years
- Less than 15,000 years
- Less than 150 years
- Unknown

1:9,028

0 0.05 0.1 0.2 mi

0 0.07 0.15 0.3 km

USGS The National Map: Orthoimagery and US Topo. Data refreshed January, 2022., Acknowledgment of the Quaternary Faults and Fold Database, the U.S. Geological Survey, and (or) the National Atlas of the United States of America would be appreciated in products derived from these data.

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Ophir Hills Grading SUP

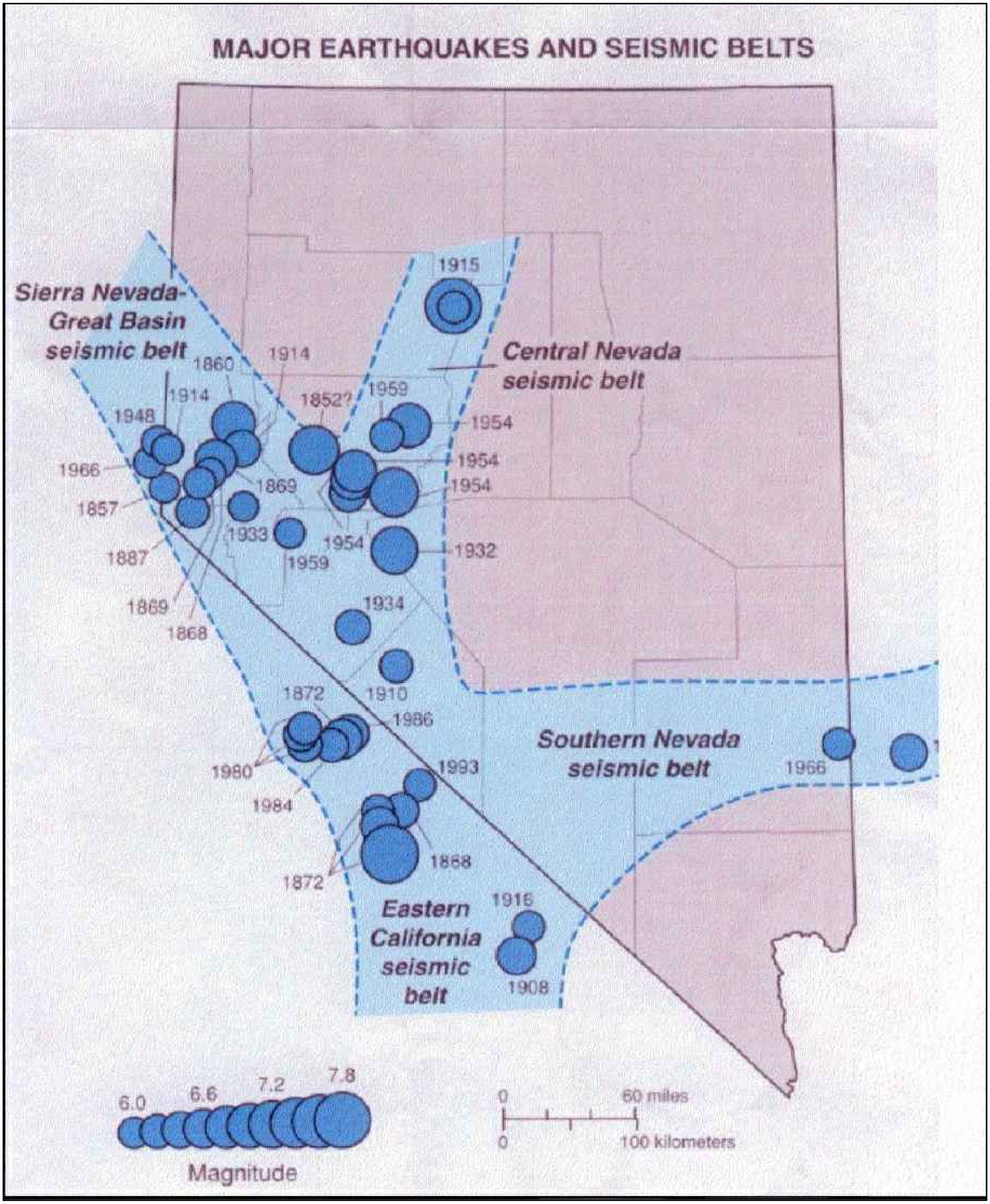
PROJECT FAULT MAP

Job Number: 9103.002

Date: May 2022

PLATE

4



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MAJOR EARTHQUAKES AND SIESMIC BELTS

Job Number: 9103.002

Date: May 2022

PLATE

4

MODIFIED MERCALLI INTENSITY SCALE

INTENSITY	EFFECTS
I	Not felt except by a very few under especially favorable circumstances.
II	Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing.
III	Felt quite noticeable indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibration like passing of truck. Duration estimated.
IV	During the day felt indoors by many, outdoors by few. At night some awaken. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building; standing motor cars rock noticeably.
V	Felt by nearly everyone; many awakened. Some dishes, windows, etc., broken; a few instances of cracked plaster; unstable objects overturned. Disturbance of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop.
VI	Felt by all; many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight.
VII	Everybody runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving motor cars.
VIII	Damage slight in specially designed structures; considerable in ordinary substantial buildings with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Disturbs persons driving motor cars.
IX	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken.
X	Some well-built wooden structures destroyed; most masonry and frame structures with foundations destroyed; ground badly cracked. Rails bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed (sloped) over banks.
XI	Few, if any (masonry) structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipe lines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.
XII	Damage total. Waves seen on ground surfaces. Lines of sight and level distorted. Objects thrown upward into the air.

From Wood and Newman, 1931, by U.S. Geological Survey, 1974, Earthquake Information Bulletin, v. 6, no. 5, p. 28

Richter Magnitude	Intensity (maximum expected Modified Mercalli)
3.0 - 3.9	II - III
4.0 - 4.9	IV - V
5.0 - 5.9	VI - VII
6.0 - 6.9	VII - VIII
7.0 - 7.9	IX - X
8.0 - 8.9	XI - XII

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Ophir Hills Grading SUP

MODIFIED MERCALLI SCALE

Job Number: 9103.002 Date: May 2022

PLATE

5

APPENDIX A

Field Exploration Logs

LUMOS
& ASSOCIATES

EXPLORATION No. TP #1

Logged By:	**J. Macaluso**	Total Depth:	**14 feet**
Date Logged:	**5/5/2022**	Water Depth:	**No groundwater encountered**
Equipment Type:	**CAT. 330 DL Excavator**	Ground Elev.:	**Existing Grade**

Sample Type legend: Percolation Test; Split Spoon; Ziplock Sample; Core Sampler; Bulk Sample (B); Static Water Table

Depth in Feet	Sample Type	SOIL DESCRIPTION	Natural Moisture Content, %	In--Place Moisture Content, %	In Place Dry Density, pcf	Liquid Limit, %	Plasticity Index, %	Gravel, % (3" - #4 Sieve)	Sand, % (#4 - #200 Sieve)	Fines, % (< #200 Sieve)	R-Value	Expansion Index
0–8.0		**<u>Medium Brown Poorly Graded SAND with Silt, Gravel, Cobbles, and Boulders (SP-SM)</u>** Loose-Medium Dense, Slightly Moist Estimated: 20% Unclassifiable Rounded to Subangular Cobbles & Boulders Up to 4' in Diameter Remainder of Soil Matrix Consisting of 20% Coarse to Fine Gravel, 70% Coarse to Fine Sand, 10% Fines										
3	B			3.1	101.7							
4				4.6	102.4							
7		Boulders Not Present After a Depth of 7'										
8.0		Organic Material (Tree Branches) at a Depth of 8' Bottom of Landslide Material										
8.0–14.0	B	**<u>Tan Poorly Graded SAND (SP)</u>** Loose-Medium Dense, Slightly Moist Estimated: 20% Coarse to Fine Gravel 80% Coarse to Fine Sand Trace Fines										
11.5	B											
12		Material Moist at a Depth of 12'										
14.0												

Test Pit terminated at 14 feet.
Test Pit backfilled without compaction verification.

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Ophir Hills Grading SUP

LOG OF EXPLORATORY TEST PIT

Job Number: 9103.002 Date: May 2022

PLATE A-1

EXPLORATION No. TP #2

Logged By:	**J. Macaluso**	Total Depth:	**13 feet**
Date Logged:	**5/5/2022**	Water Depth:	**No groundwater encountered**
Equipment Type:	**CAT. 330 DL Excavator**	Ground Elev.:	**Existing Grade**

Legend: Percolation Test; Split Spoon; Ziplock Sample; Core Sampler; Bulk Sample; Static Water Table

Depth in Feet	Graphic Log	Sample Type	SOIL DESCRIPTION	Natural Moisture Content, %	In--Place Moisture Content, %	In Place Dry Density, pcf	Liquid Limit, %	Plasticity Index, %	Gravel, % (3" - #4 Sieve)	Sand, % (#4 - #200 Sieve)	Fines, % (< #200 Sieve)	R-Value	Expansion Index
0–7			**Medium Brown Poorly Graded SAND with Silt, Gravel, and Cobble (SP-SM)** Loose, Slightly Moist Estimated: 20% Unclassifiable Rounded to Subangular Boulders Up to 4' in Diameter										
3		B			4.9	101.1						77	
5		B		3.7	5.4	111.1	NP	NP	25.8	56.4	10.0		
7.0			Clear Change in Strata at a Depth of 7' None to Few Boulders After 7' Bottom of Landslide Material										
7–13			**Whitish-Tan Poorly Graded SAND (SP)** Loose, Slightly Moist Estimated: 10% Coarse to Fine Gravel 90% Coarse to Fine Sand Trace Fines										
11		B	Material Moist at a Depth of 11'										
13.0													

Test Pit terminated at 13 feet.
Test Pit backfilled without compaction verification.

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LOG OF EXPLORATORY TEST PIT

Job Number: 9103.002 Date: May 2022

PLATE A-2

EXPLORATION No. TP #3

Logged By:	**J. Macaluso**	Total Depth:	**14.5 feet**
Date Logged:	**5/5/2022**	Water Depth:	**No groundwater encountered**
Equipment Type:	**CAT. 330 DL Excavator**	Ground Elev.:	**Existing Grade**

Sample type legend: Percolation Test; Split Spoon; Ziplock Sample; Core Sampler; Bulk Sample; Static Water Table

Depth in Feet	Graphic Log	Sample Type	SOIL DESCRIPTION	Natural Moisture Content, %	In--Place Moisture Content, %	In Place Dry Density, pcf	Liquid Limit, %	Plasticity Index, %	Gravel, % (3" - #4 Sieve)	Sand, % (#4 - #200 Sieve)	Fines, % (< #200 Sieve)	R-Value	Expansion Index
0–4.0			**Olive Brown Silty SAND (SM)** **Non-Homogeneous Mix of Poorly Graded Sand and Silt Chunks** Loose-Medium Dense, Slightly Moist. Contains Debris: Asphalt and Metal. **Maximum Dry Density and Optimum Moisture Content:** **Corrected - 123.5 p.c.f. at 10.5%** **Uncorrected - 121.4 p.c.f. at 11.2%**										
3		B		7.3	9.6	100.2	NP	NP	13.9	67.4	18.7		
4.0–14.5			**Whitish Tan Poorly Graded SAND with Silt (SP-SM)** Loose, Slightly Moist. Estimated: 90% Medium to Fine Sand, 10% Fines. Tree Branch at a Depth of 6'										
4.5		B			5.0	91.6							
12.5		B	at a Depth of 12' the Sand Particles Become More Coarse and Material is Mottled										

Test Pit terminated at 14.5 feet.
Test Pit backfilled without compaction verification.

LUMOS_TP_FULL_PAGE OPHIR HILLS SUP GEO.GPJ US_LAB.GDT 5/16/22

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Ophir Hills Grading SUP

LOG OF EXPLORATORY TEST PIT

Job Number: 9103.002 Date: May 2022

PLATE A-3

EXPLORATION No. TP #4

Logged By:	**J. Macaluso**	Total Depth:	**15 feet**
Date Logged:	**5/5/2022**	Water Depth:	**No groundwater encountered**
Equipment Type:	**CAT. 330 DL Excavator**	Ground Elev.:	**Existing Grade**

Sample types: Percolation Test; Split Spoon; Ziplock Sample; Core Sampler; Bulk Sample; Static Water Table

Depth in Feet	Graphic Log	Sample Type	SOIL DESCRIPTION	Natural Moisture Content, %	In--Place Moisture Content, %	In Place Dry Density, pcf	Liquid Limit, %	Plasticity Index, %	Gravel, % (3" - #4 Sieve)	Sand, % (#4 - #200 Sieve)	Fines, % (< #200 Sieve)	R-Value	Expansion Index
0–3			**Medium Brown Poorly Graded SAND with Silt (SP-SM)** Loose-Medium Dense, Slightly Moist Estimated: 10% Coarse to Fine Gravel 80% Medium to Fine Sand 10% Fines										
3–4		B			4.7	104.0							
4–5			Debris at a Depth of 4.5'		5.2	112.6							
7–8			Thin Black (Possibly Organic) Lens at 8' with a Layer of Cobbles and Boulders Directly above the Lens Bottom of Landslide Material 8.0										
8–13			**Tan Poorly Graded SAND with Silt (SP-SM)** Loose-Medium Dense, Slightly Moist-Moist Estimated: Trace Gravel 90% Coarse to Fine Sand 10% Fines										
13–14		B											
15			15.0										

Test Pit terminated at 15 feet.
Test Pit backfilled without compaction verification.

LUMOS_TP_FULL_PAGE_OPHIR HILLS SUP GEO.GPJ_US_LAB.GDT_5/16/22

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LOG OF EXPLORATORY TEST PIT

Job Number: 9103.002 Date: May 2022

PLATE A-4

EXPLORATION No. TP #5

Logged By:	**J. Macaluso**	Total Depth:	**13.5 feet**
Date Logged:	**5/5/2022**	Water Depth:	**No groundwater encountered**
Equipment Type:	**CAT. 330 DL Excavator**	Ground Elev.:	**Existing Grade**

Sample type legend: Percolation Test; Split Spoon; Ziplock Sample; Core Sampler; B Bulk Sample; ▼ Static Water Table

Depth in Feet	Graphic Log	Sample Type	SOIL DESCRIPTION	Natural Moisture Content, %	In-Place Moisture Content, %	In Place Dry Density, pcf	Liquid Limit, %	Plasticity Index, %	Gravel, % (3" - #4 Sieve)	Sand, % (#4 - #200 Sieve)	Fines, % (< #200 Sieve)	R-Value	Expansion Index
0–0.7			**8" of Mulch** (0.7)										
0.7–13.5			**Tan Poorly Graded SAND with Silt, Gravel, Cobbles, and Boulders (SP-SM)** Loose, Slightly Moist Estimated: 10% Unclassifiable Cobbles and Boulders up to 3' in Diameter with the Remainder of the Matrix Consisting of 20% Coarse to Fine Gravel 70% Coarse to Fine Sand 10% Fines Thin Black (Possibly Organic) Lens at 4' with a Decomposing Tree Branch Directly Above Lens Possible Bottom of Landslide Material, However No Discernible Change in Composition or Color in Underlying Material (13.5)										
2–3		B			7.3	105.8							
4.5–5.5		B			3.4	109.4							
11–12		B											

Test Pit terminated at 13.5 feet.
Test Pit backfilled without compaction verification.

LUMOS_TP_FULL_PAGE OPHIR HILLS SUP GEO.GPJ US_LAB.GDT 5/16/22

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LOG OF EXPLORATORY TEST PIT

Job Number: 9103.002 Date: May 2022

PLATE A-5

EXPLORATION No. TP #6

Logged By:	J. Macaluso	Total Depth:	14 feet
Date Logged:	5/5/2022	Water Depth:	No groundwater encountered
Equipment Type:	CAT. 330 DL Excavator	Ground Elev.:	Existing Grade

Sample Type legend: Percolation Test; Split Spoon; Ziplock Sample; Core Sampler; Bulk Sample (B); Static Water Table

Depth in Feet	Sample Type	SOIL DESCRIPTION	Natural Moisture Content, %	In--Place Moisture Content, %	In Place Dry Density, pcf	Liquid Limit, %	Plasticity Index, %	Gravel, % (3" - #4 Sieve)	Sand, % (#4 - #200 Sieve)	Fines, % (< #200 Sieve)	R-Value	Expansion Index
0–6.0		**Yellow Brown Well Graded SAND with Silt, Cobbles, and Boulders (SW-SM)** Loose, Slightly Moist Estimated: 20% Unclassifiable Cobbles and Boulders up to 4' in Diameter **Maximum Dry Density and Optimum Moisture Content:** **117.8 p.c.f. at 10.8%**										
3–4	B		3.2	3.6	102.0	NP	NP	3.5	89.5	7.0		
4.5–5.5	B	Clear Change in Strata at a Depth of 6' Bottom of Landslide Material		4.4	102.0							
6.0–8.0		**Whitish Tan Poorly Grade SAND (SP)** Loose-Medium Dense, Slightly Moist Estimated: 10% Coarse to Fine Gravel, 90% Coarse to Fine Sand, Trace Fines										
8.0–14.0		**Tan Poorly Graded SAND with Silt, Gravel, and Cobbles (SP-SM)** Loose-Medium Dense, Slightly Moist Estimated: 20% Unclassifiable Cobble up to 8" in Diameter with the Remainder of the Matrix Consisting of 20% Coarse to Fine Gravel 70% Coarse to Fine Sand 10% Fines										
13–14	B											

Test Pit terminated at 14 feet.
Test Pit backfilled without compaction verification.

LUMOS_TP_FULL_PAGE_OPHIR HILLS SUP GEO.GPJ US_LAB.GDT 5/16/22

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Ophir Hills Grading SUP

LOG OF EXPLORATORY TEST PIT

Job Number: 9103.002 Date: May 2022

PLATE A-6

EXPLORATION No. TP #7

Logged By:	**J. Macaluso**	Total Depth:	**14 feet**
Date Logged:	**5/5/2022**	Water Depth:	**No groundwater encountered**
Equipment Type:	**CAT. 330 DL Excavator**	Ground Elev.:	**Existing Grade**

Legend: Percolation Test; Split Spoon; Ziplock Sample; Core Sampler; Bulk Sample; Static Water Table

Depth in Feet	Graphic Log	Sample Type	SOIL DESCRIPTION	Natural Moisture Content, %	In-Place Moisture Content, %	In Place Dry Density, pcf	Liquid Limit, %	Plasticity Index, %	Gravel, % (3" - #4 Sieve)	Sand, % (#4 - #200 Sieve)	Fines, % (< #200 Sieve)	R-Value	Expansion Index
0–4.0		B (at 3)	**Medium Brown Silty SAND (SM)** Loose-Medium Dense, Slightly Moist Estimated: Trace Gravel 80% Coarse to Fine Sand 20% Fines 4.0		4.1	116.1							
4.0–8.0		B (at 7)	**Medium Brown Poorly Graded SAND with Silt, Gravel, Cobble, and Boulders (SP-SM)** Loose-Medium Dense, Slightly Moist Estimated: 20% Unclassifiable Cobble and Boulders up to 3' in Diameter with the Remainder of the Matrix Consisting of 20% Coarse to Fine Gravel 70% Coarse to Fine Sand 10% Fines Distinct Layer of Boulders at a Depth of 7', Boulders Sparsly Present Below 7' Possible Bottom of Landslide Material 8.0		5.0	107.2							
8.0–9.0			**Whitish Tan Poorly Graded SAND (SP)** Loose-Medium Dense, Slightly Moist Estimated: 10% Coarse to Fine Gravel, 90% Coarse to Fine Sand, Trace Fines 9.0										
9.0–14.0		B (at 12.5)	**Medium Brown Silty SAND with Gravel, Cobbles, and Boulders (SM)** Loose-Medium Dense, Slightly Moist Estimated: 5% Unclassifiable Cobble and Boulders up to 2' in Diameter with the Remainder of the Matrix Consisting of 20% Coarse to Fine Gravel 60% Coarse to Fine Sand 20% Fines 14.0										

Test Pit terminated at 14 feet.
Test Pit backfilled without compaction verification.

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Ophir Hills Grading SUP

LOG OF EXPLORATORY TEST PIT

Job Number: 9103.002 Date: May 2022

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

Other Tests

AN	ANALYTICAL TEST (pH, Soluble Sulfate, and Resistivity)
C	CONSOLIDATION TEST
DS	DIRECT SHEAR TEST
MD	MOISTURE DENSITY CURVE

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Ophir Hills Grading SUP

LEGEND

Job Number: 9103.002

Date: May 2022

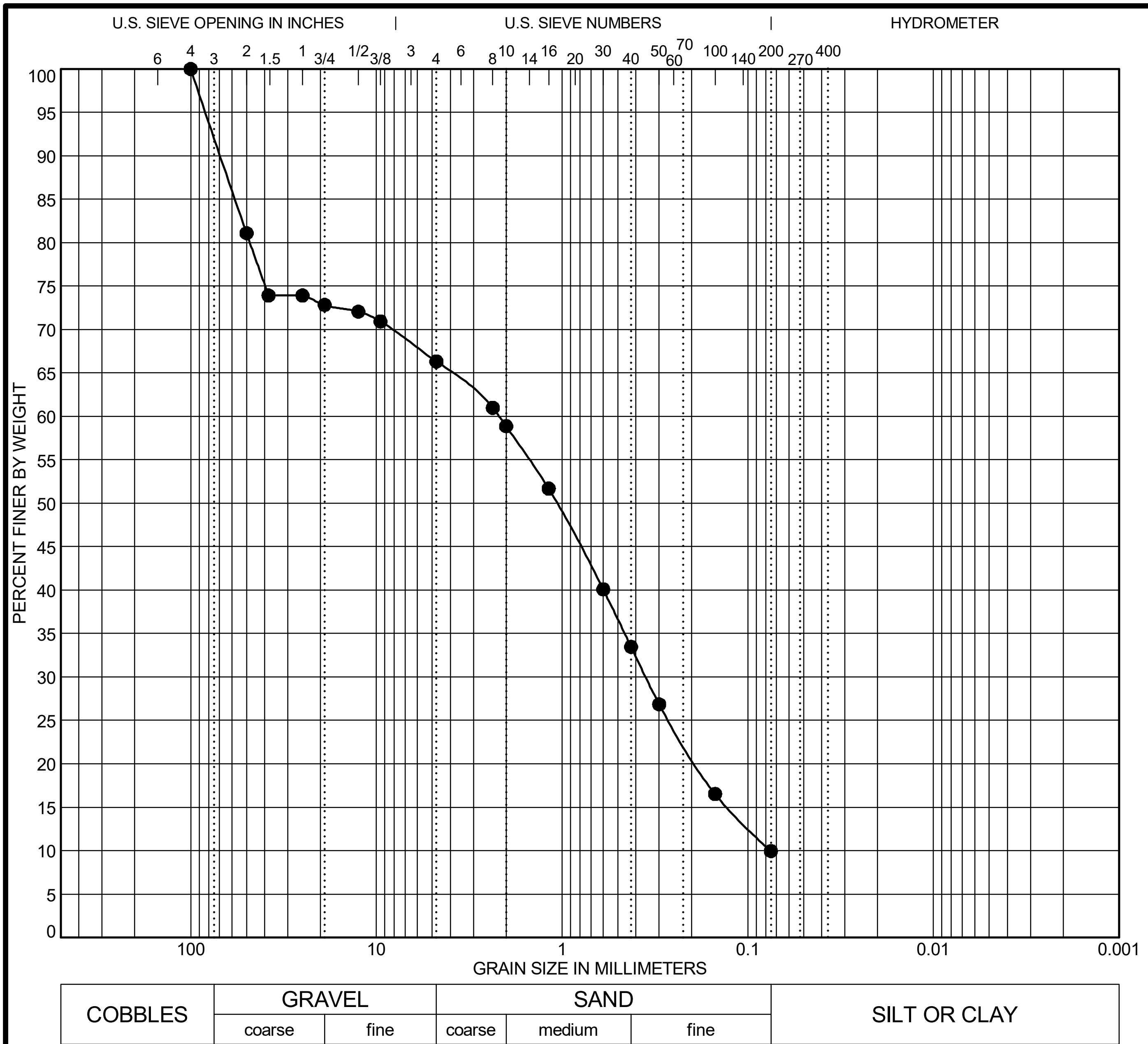
PLATE

A-8

APPENDIX B

Soils Laboratory Test Results

LUMOS
& ASSOCIATES



Specimen Identification		Date: 5/6/2022					
●	TP #2	Classification	LL	PL	PI	Cc	Cu
	Depth: 4.5	Poorly Graded SAND with Silt, Gravel, and Boulders	NP	NP	NP	0.8	29.0
	Sample Location	Test Pit #2, 4.5'-5.5'					
	USCS	SP-SM					
	AASHTO						

Specimen Identification									
●	TP #2	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
	Depth: 4.5	100	2.185	0.354	0.075	25.8	56.4	10.0	

Natural Moisture	3.7 %		**S.E.**		**Absorption %**	
R-Value			**Durability Index**		**Soundness**	
Perctage of Wear (500 rev)	%		**Specific Gravity**		**Direct Shear**	

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Ophir Hills Grading SUP

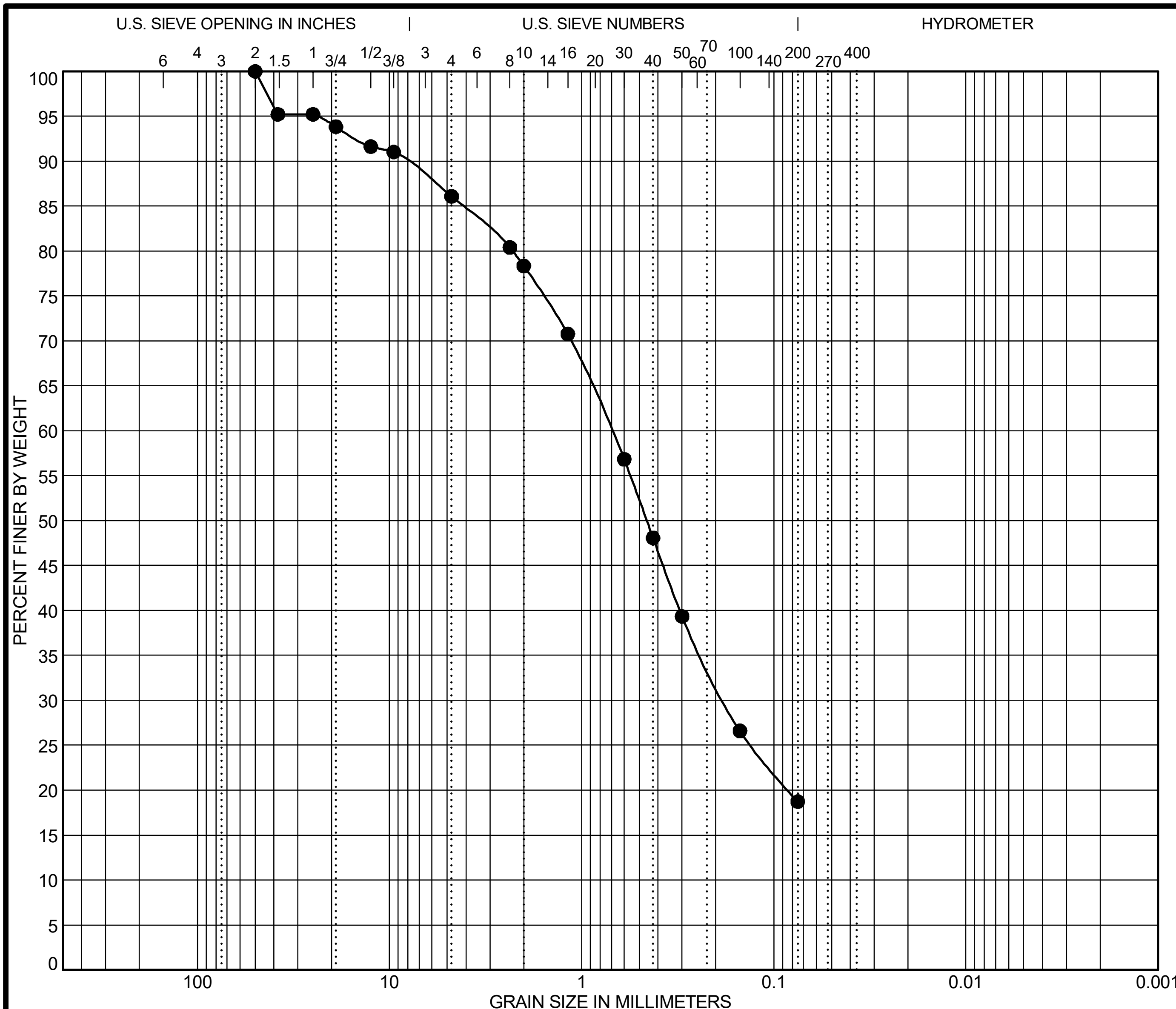
GRAIN SIZE DISTRIBUTION

Job Number: 9103.002

Date: May 2022

PLATE

B-1.1



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Date: 5/6/2022					
● TP #3	Classification	LL	PL	PI	Cc	Cu
Depth: 2.5	Silty SAND (SM)	NP	NP	NP		
Sample Location	Test Pit #3, 2.5'-3.5'					
USCS	SM					
AASHTO						

Specimen Identification								
● TP #3	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
Depth: 2.5	50	0.7	0.181		13.9	67.4	18.7	

Natural Moisture	7.3 %		**S.E.**		**Absorption %**	
R-Value			**Durability Index**		**Soundness**	
Perctage of Wear (500 rev)	%		**Specific Gravity**		**Direct Shear**	

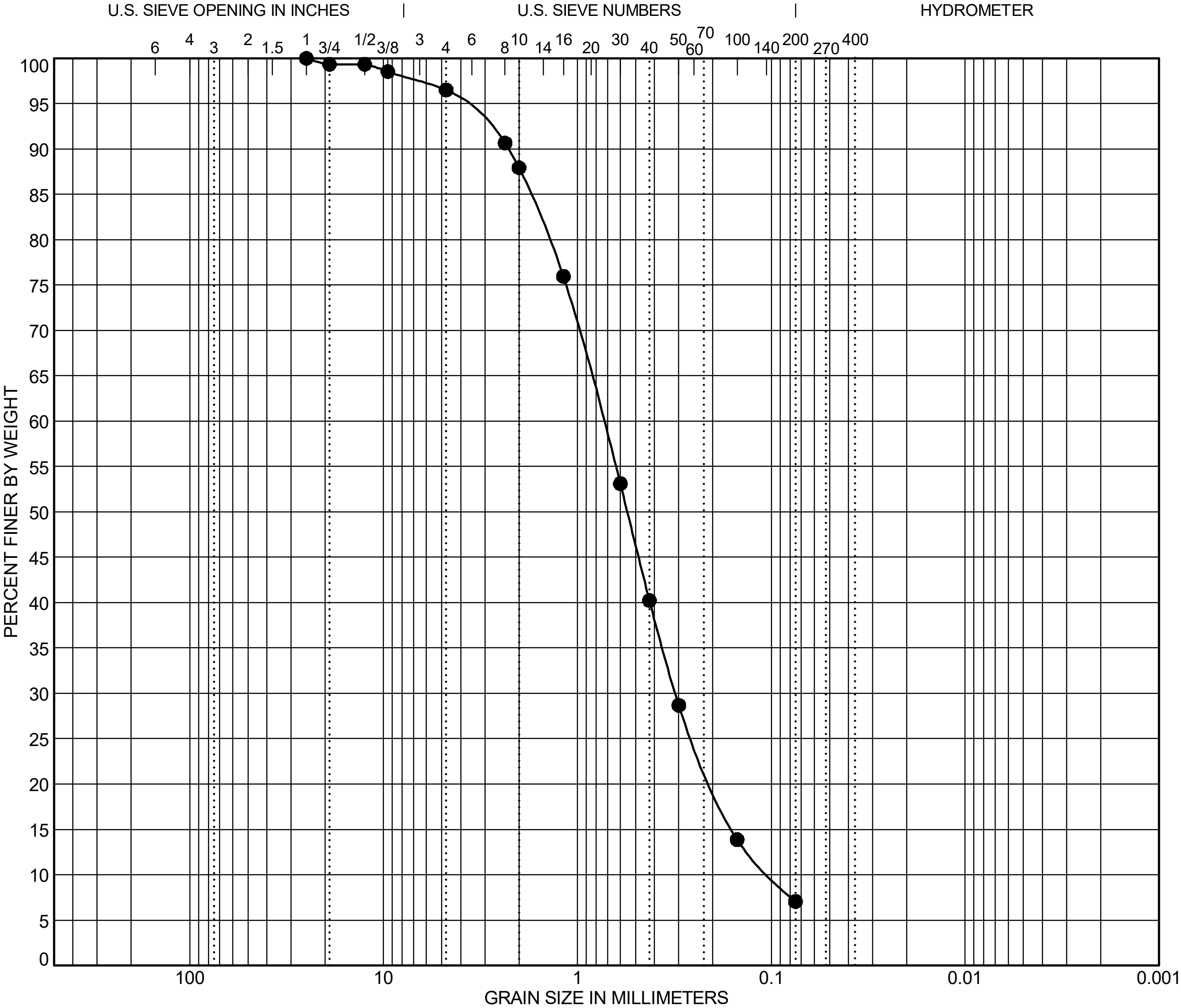
Lumos & Associates
808 E. College Parkway, Suite 101
Carson City, NV 89703
775.883.7077
Fax: 775.883.7114
mburns@lumosinc.com

Ophir Hills Grading SUP

GRAIN SIZE DISTRIBUTION

Job Number: 9103.002 Date: May 2022

PLATE B-1.2



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Date: 5/6/2022					
● TP #6	Classification	LL	PL	PI	Cc	Cu
Depth: 3	Well Graded SAND with Silt	NP	NP	NP	1.3	7.3
Sample Location	Test Pit #6, 3'-4'					
USCS	SW-SM					
AASHTO						

Specimen Identification								
● TP #6	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
Depth: 3	25	0.736	0.312	0.101	3.5	89.5	7.0	

Natural Moisture	3.2 %	**S.E.**		**Absorption %**	
R-Value		**Durability Index**		**Soundness**	
Perctage of Wear (500 rev)	%	**Specific Gravity**		**Direct Shear**	

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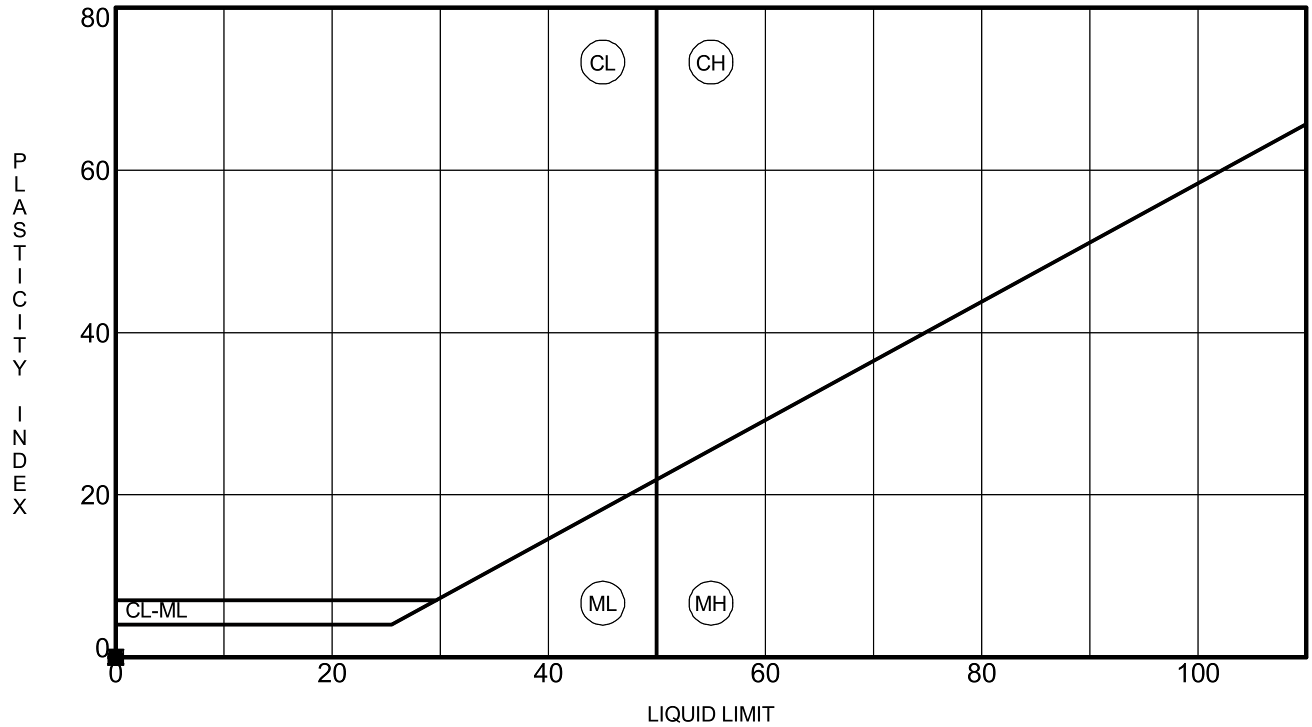
Ophir Hills Grading SUP

GRAIN SIZE DISTRIBUTION

Job Number: 9103.002

Date: May 2022

PLATE B-1.3



	Specimen Identification		LL	PL	PI	Fines	Classification
●	**TP #2**	**4.5**	**NP**	**NP**	**NP**	**10**	Poorly Graded SAND with Silt, Gravel, and Boulders
⧗	**TP #3**	**2.5**	**NP**	**NP**	**NP**	**19**	Silty SAND (SM)
▲	**TP #6**	**3.0**	**NP**	**NP**	**NP**	**7**	Well Graded SAND with Silt

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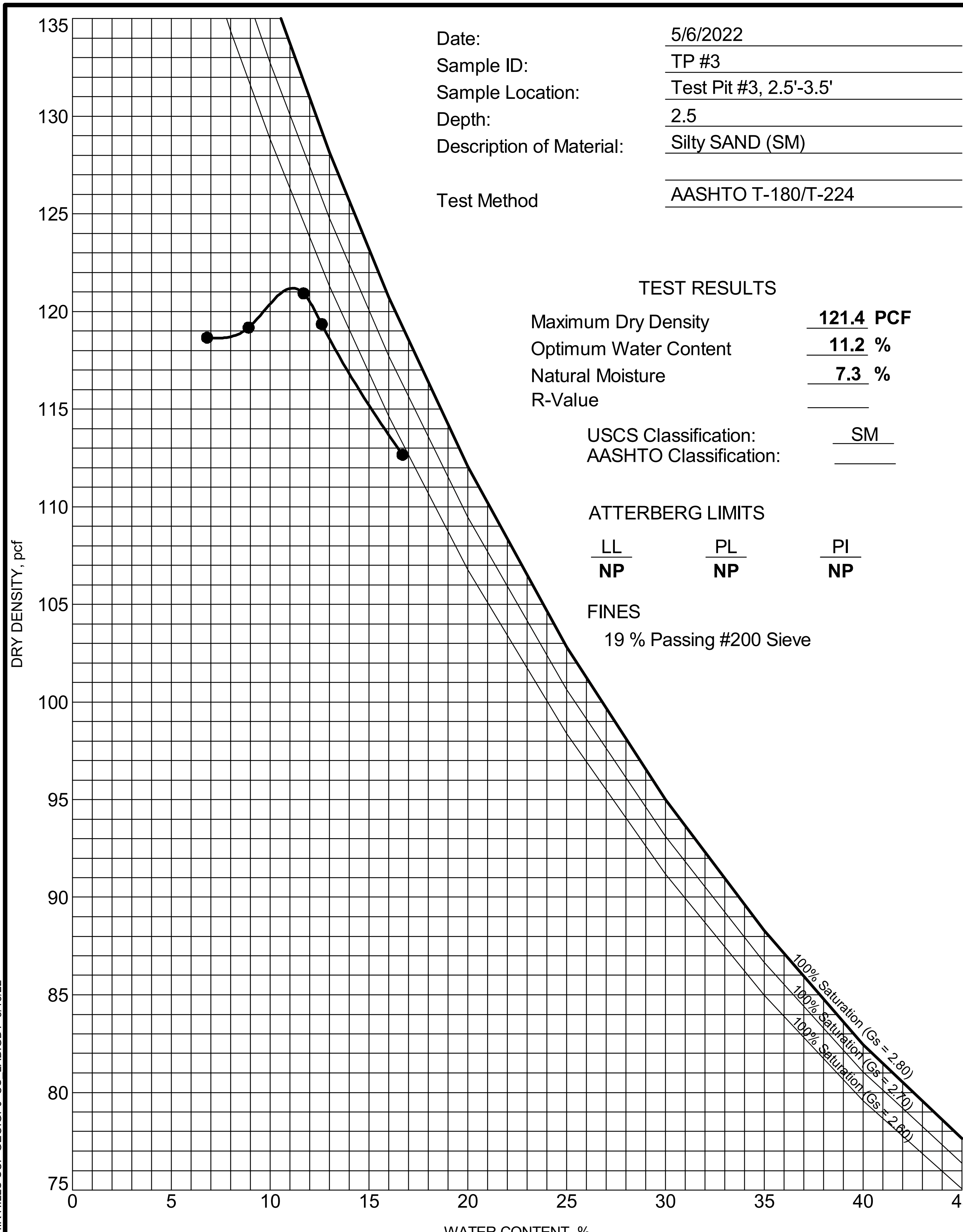
Ophir Hills Grading SUP

ATTERBERG LIMITS' RESULTS

Job Number: 9103.002 Date: May 2022

PLATE

B-2



Date: 5/6/2022
Sample ID: TP #3
Sample Location: Test Pit #3, 2.5'-3.5'
Depth: 2.5
Description of Material: Silty SAND (SM)

Test Method: AASHTO T-180/T-224

TEST RESULTS

Maximum Dry Density **121.4 PCF**
Optimum Water Content **11.2 %**
Natural Moisture **7.3 %**
R-Value

USCS Classification: SM
AASHTO Classification:

ATTERBERG LIMITS

LL	PL	PI
NP	**NP**	**NP**

FINES
19 % Passing #200 Sieve

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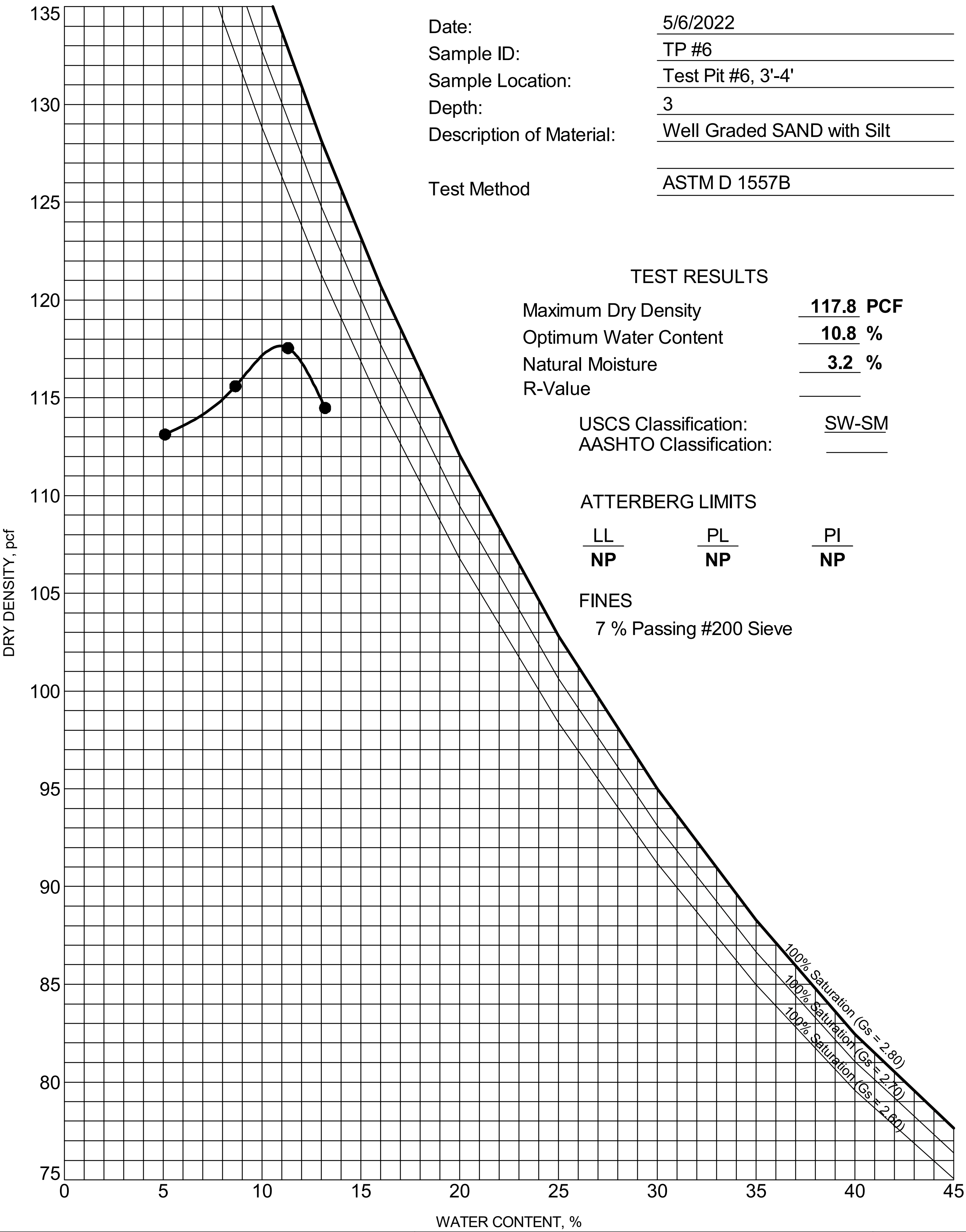
Ophir Hills Grading SUP

MOISTURE-DENSITY CURVE

Job Number: 9103.002 Date: May 2022

PLATE

B-3.1



Date:	5/6/2022
Sample ID:	TP #6
Sample Location:	Test Pit #6, 3'-4'
Depth:	3
Description of Material:	Well Graded SAND with Silt
Test Method	ASTM D 1557B

TEST RESULTS

Maximum Dry Density	**117.8**	**PCF**
Optimum Water Content	**10.8**	**%**
Natural Moisture	**3.2**	**%**
R-Value		

USCS Classification: SW-SM
AASHTO Classification:

ATTERBERG LIMITS

LL	PL	PI
NP	**NP**	**NP**

FINES
7 % Passing #200 Sieve

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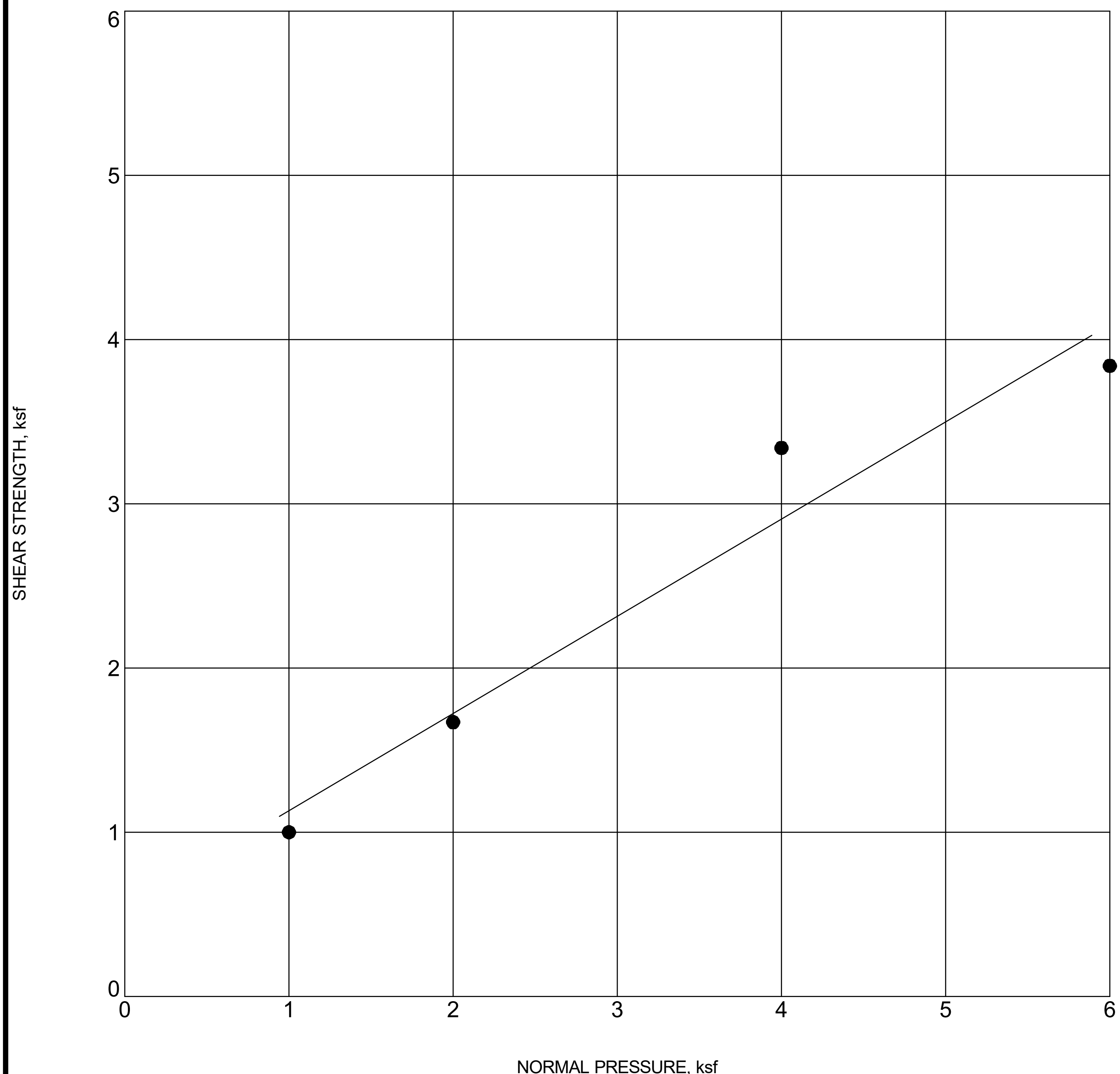
Ophir Hills Grading SUP

MOISTURE-DENSITY CURVE

Job Number: 9103.002
Date: May 2022

PLATE
B-3.2



	Specimen Identification		Classification	γ_d	MC%	c	ϕ
●	**TP #6**	**3.0**	**Well Graded SAND with Silt**	**106**	**11**	**0.54**	**30.6**

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Ophir Hills Grading SUP

DIRECT SHEAR TEST

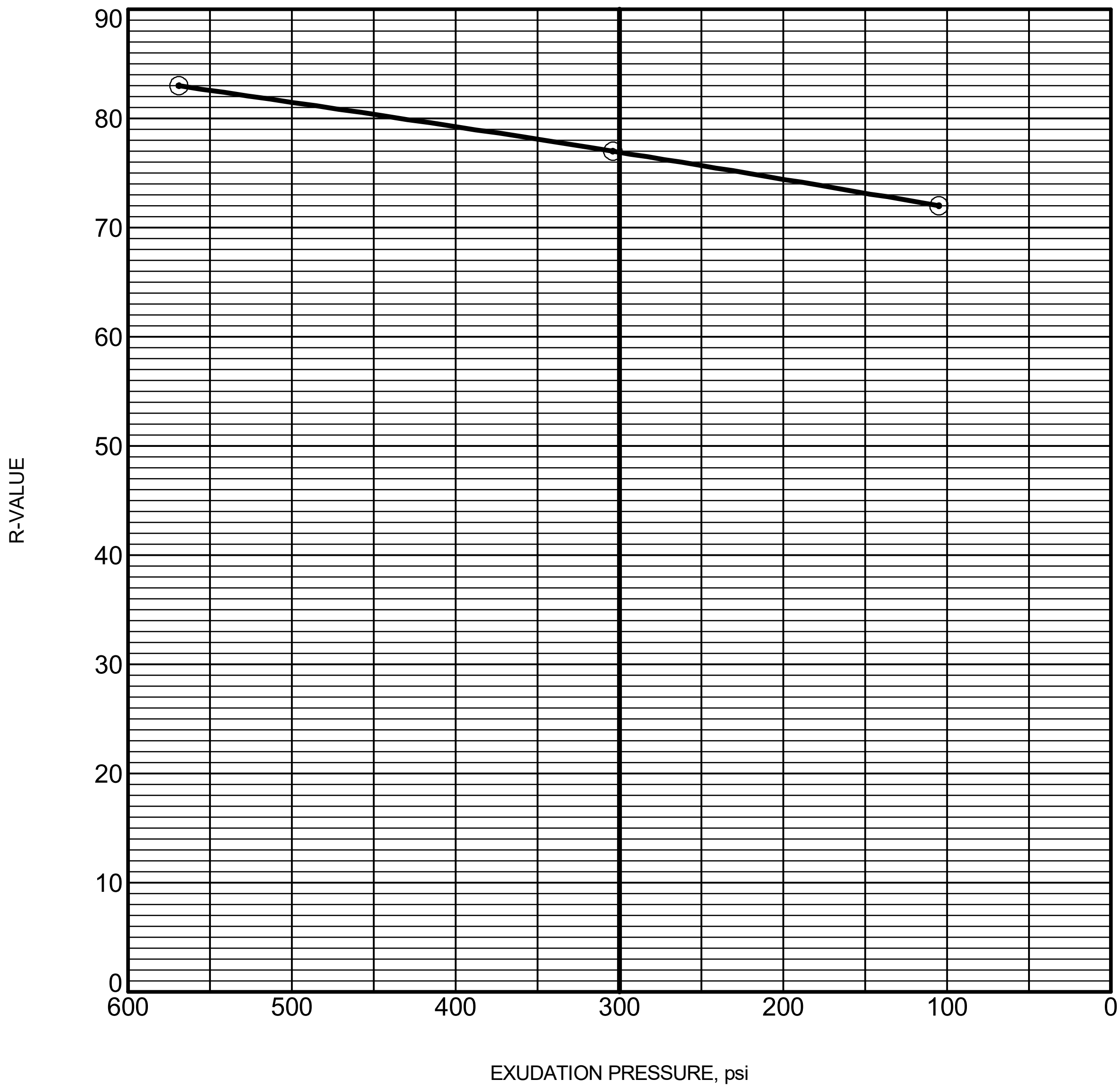
Job Number: 9103.002

Date: May 2022

PLATE

B-4

LUMOS DIRECT SHEAR OPHIR HILLS SUP GEO.GPJ US LAB.GDT 5/13/22



Test Data

Specimen No.	Water Content (%)	Dry Density (pcf)	Expansion (psf)	Exudation (psi)	Test R-Value*
1	**10.7**	**123.7**	**0.0**	**105.0**	**72.0**
2	**9.6**	**124.6**	**0.0**	**304.0**	**77.0**
3	**8.7**	**569.0**	**0.0**	**569.0**	**83.0**

* Reported values have been corrected for sample height, where required.

Test Result

Specimen Identification		Classification	R-Value
TP #2	**2.5**	**Poorly Graded SAND with Silt, Gravel, and Boulders**	**77**

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Ophir Hills Grading SUP

RESISTANCE VALUE TEST

Job Number: 9103.002 Date: May 2022

PLATE

B-5

Silver State Labs-Reno
1135 Financial Blvd
Reno, NV 89502
(775) 857-2400 FAX: (888) 398-7002
www.ssalabs.com

Analytical Report

Workorder#: **22050510**
Date Reported: **5/19/2022**

Client: Lumos and Associates - Reno
Project Name: 9103.002 / Ophir Hills Sup - TP-1 2.5' - 3.5'
PO #: 9103.002/MTB
Sampled By: J. Macaluso

Laboratory Accreditation Number: NV015/CA2990

Laboratory ID	Client Sample ID	Date/Time Sampled	Date Received
22050510-01	Ophir Hills Sup - TP-1 2.5' - 3.5'	05/05/2022 0:00	5/9/2022

Parameter	Method	Result	Units	PQL	Analyst	Date/Time Analyzed	Data Flag
Chloride	EPA 9056	<50	mg/Kg	50	CTR	05/18/2022 13:11	
pH	SW-846 9045D	5.64	pH Units		AC	05/17/2022 10:31	
pH Temperature	SW-846 9045D	22.0	°C		AC	05/17/2022 10:31	
Resistivity	AASHTO T288	17000	Ohms-cm		SR	05/12/2022 13:34	
Sodium	ASTM D2791	< 0.01	%	0.01	AC	05/16/2022 10:00	
Sodium Sulfate as Na2SO4	Calculation	< 0.01	%	0.01	AC	05/18/2022 10:58	
Solubility	SM 2540C	0.036	%	0.01	DL	05/13/2022 10:04	
Sulfate	SM4500 SO4E	< 0.010	%	0.01	SR	05/17/2022 9:43	

Original

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Ophir Hills Grading SUP

ANALYTICAL TESTING

Job Number: 9103.002 Date: May 2022

PLATE B-6

APPENDIX C

Design Response Spectrum

LUMOS
& ASSOCIATES

ATC Hazards by Location

Search Information

Coordinates: 39.29280502470283, -119.82831037044527

Elevation: 5087 ft

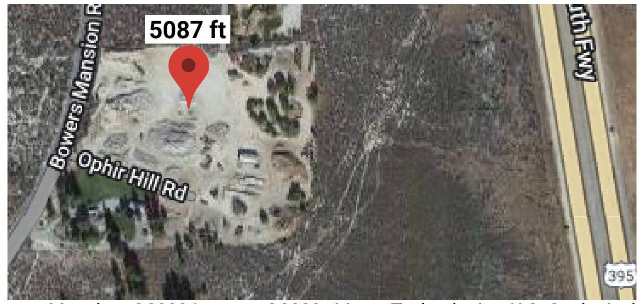
Timestamp: 2022-05-13T17:27:17.686Z

Hazard Type: Seismic

Reference Document: ASCE7-16

Risk Category: II

Site Class: D-default



Map data ©2022 Imagery ©2022 , Maxar Technologies, U.S. Geological Survey, USDA/FPAC/GEO

Basic Parameters

Name	Value	Description
S_S	2.15	MCE_R ground motion (period=0.2s)
S_1	0.764	MCE_R ground motion (period=1.0s)
S_{MS}	2.58	Site-modified spectral acceleration value
S_{M1}	* null	Site-modified spectral acceleration value
S_{DS}	1.72	Numeric seismic design value at 0.2s SA
S_{D1}	* null	Numeric seismic design value at 1.0s SA

* See Section 11.4.8

Additional Information

Name	Value	Description
SDC	* null	Seismic design category
F_a	1.2	Site amplification factor at 0.2s
F_v	* null	Site amplification factor at 1.0s
CR_S	0.887	Coefficient of risk (0.2s)
CR_1	0.879	Coefficient of risk (1.0s)
PGA	0.923	MCE_G peak ground acceleration
F_{PGA}	1.2	Site amplification factor at PGA
PGA_M	1.107	Site modified peak ground acceleration
T_L	6	Long-period transition period (s)

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Ophir Hills Grading SUP

DESIGN RESPONSE SPECTRUM

Job Number: 9103.002 Date: May 2022

PLATE C-1

APPENDIX D

Pavement Design

Job Number: 9103.002
Project: Ophir Hill Grading SUP
Client: Burdick Excavating
Description: Pavement Calculations
By: J. Macaluso

R-Value for Native Subgrade = 77 (Laboratory Test Result)
R-Value for Structural Fill = 45 (Specification)
R-Value for Aggregate Base = 70 (Type 2 Class B Aggregate Base)
TI (Traffic Index) = 5 (Light Truck/Car Traffic)

GE=0.0032*(TI)*(100-R)

$G_{f\,(AC)}$=2.5, $G_{f(Base)}$=1.1,
t_{layer}=GE/G_f

GE_{AC}=0.0032*(5)*(100-70)=0.48'
t_{AC}=(0.48'/2.50)*(12"/1')=2.3" **USE 3" Asphalt Concrete**
GE_{AC}=(3"*2.50)/(12")=0.63'

GE_{Base}=0.0032*(5)*(100-45)=0.88'
t_{Base}=((0.88'-0.63')/1.1)*(12"/1') = 2.8" **USE 4" Aggregate Base**

Therefore, 3" of Asphalt Concrete (AC) underlain by a minimum of 4" of Aggregate Base, underlain by 24" of properly prepared sub-grade for car and light truck traffic

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Ophir Hills Grading SUP

PAVEMENT DESIGN

Job Number: 9103.002 Date: May 2022

PLATE

D-1